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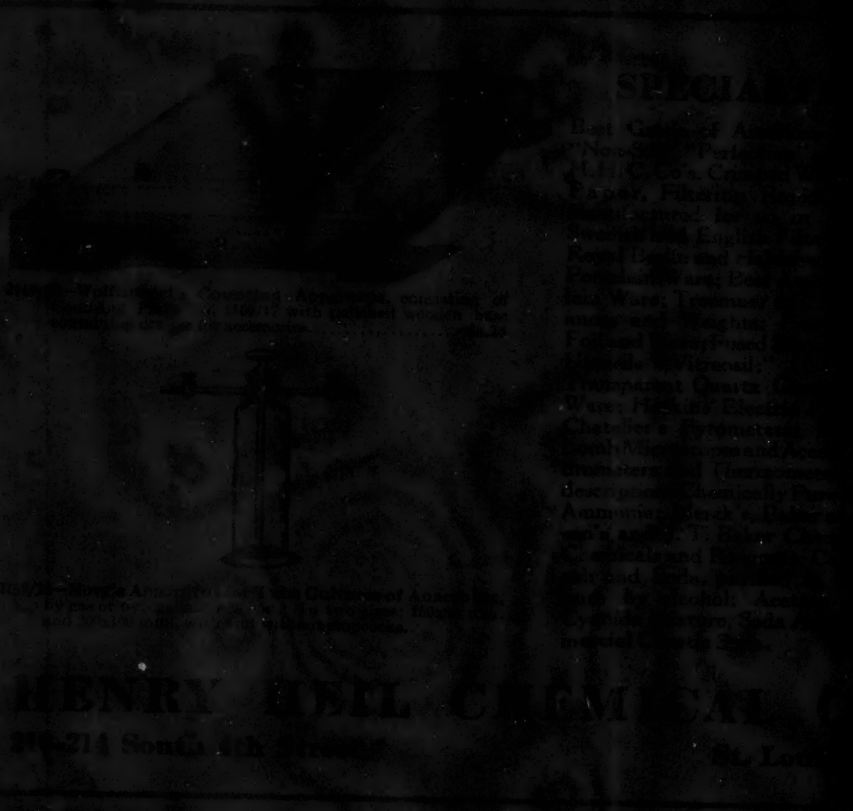

HENRY HOEL CHEMICAL

SPECIA

PHYTOPATHOLOGY

VOLUME XI NUMBER 4

APRIL, 1921.

AN ATTACK OF POPLAR CANKER FOLLOWING FIRE INJURY

ALFRED H. W. POVAH

WITH THREE FIGURES IN THE TEXT

INTRODUCTION

Three years ago Long (3) described a poplar canker caused by *Cytospora chrysosperma* (Pers.) Fr. as occurring commonly in the Southwest. He pointed out that this disease is not "an active parasite on the well-cared for, more resistant species of poplar," but attacks trees only when their resistance is lowered by such adverse conditions as (a) lack of water, (b) unfavorable environment, and (c) severe pruning. He found that cuttings in propagation beds are subject to the disease. Long lists ten species of poplar and three species of willow as hosts.

Recently Hubert (2) has given data on hosts and range of this pathogen in the Northwest. He notes that this disease often follows fire injury. As new hosts are given: three species of maple, *Prunus demissa*, *Sambucus glauca*, *Populus trichocarpa*, *Salix lasiandra*, and *Sorbus scopulina*.

Concerning the distribution of the fungus Long (3) says "*Cytospora chrysosperma* is rather widely distributed in certain sections of the United States, especially in the Southwestern States. It ranges from Texas and Kansas northward to Montana and westward to California. It has been found in nine states—Arizona, Colorado, Kansas, Montana, Nevada, New Mexico, North Dakota, South Dakota, and Texas; and also in Mexico. The fungus is widely distributed in Europe." Hubert (2) adds Idaho, Washington and Wyoming to the list, making a total of twelve states. So far as the writer is aware the disease caused by this fungus is here reported for the first time from east of the Mississippi.

FIELD DATA

The writer's attention was first called to this disease the early part of

last June when he noticed, beside a railroad track in the vicinity of Syracuse, N. Y., a small tree of *Populus grandidentata* Michx. (Tree No. 1, table 1), 1¾ inches in diameter which had died when the new shoots were 1½ inches long (Fig. 1). Upon examination this tree was found to be heavily infected with *Cytospora chrysosperma*,[1] one canker extending from the ground 3½ feet up the trunk. Infections covering approximately two-thirds of the surface were found on two branches each 1 inch in diameter, located about 1 foot above the ground. These two branches were killed just as the buds opened (Fig. 1).

A glance showed that a light ground fire had run through the woods, probably set by a spark from a passing locomotive. Inquiry of one of the railroad men placed the approximate time of the fire as the middle of April. Apparently the disease was limited to the burned area as trees close to infected ones were not diseased if they were not in the path of the fire. Moreover, an examination of the poplars in the surrounding territory failed to reveal a single case of infection. It should be pointed out that although the pathogen is a weak parasite it can kill when the host is in a weakened condition. The mortality, as shown in table 1, is believed to be due to the disease as no case was found in the area in which fire injury was sufficient to cause death. In a few places the shrubs had been killed by the fire but, from the general appearance of the area, it was concluded that the effect of the fire was relatively small as far as the trees were concerned.

FIG. 1. POPLAR KILLED BY CYTOSPORA CHRYSOSPERMA.

Tree of Populus grandidentata (No. 1, table 1) killed when the new shoots were 1½ inches long. The two lower branches were killed as the buds opened.

A survey of the area showed that both *P. grandidentata* and *P. tremuloides* Michx. were infected. Table 1 shows the result of a survey on July 23. From this table we note that of the 73 poplars in the area, 50 were infected and 27 killed. Expressed in percentage this would be 68.4 per cent infected and 36.9 per cent killed. Of the 43 trees of *P. tremuloides* 31 trees, or 72 per cent were infected and 21 trees, or 48.9 per cent killed. In the case of *P. grandidentata* we find that 19 of the

[1] Material was submitted to W. H. Long who confirmed the author's identification.

TABLE 1.

Field data on Populus tremuloides and Populus grandidentata

TREE NUMBER	SPECIES*	DIAMETER BREAST HIGH IN INCHES	STATE (U = UNINFECTED I = INFECTED)	SIZE OF CANKER	CONDITION OF TREE JULY 23
1	G	1.75	I	Girdled for 1½ ft.	Killed when new shoots 1½ in.
2	G	1.50	I	Girdled for 8 ft.	Killed as buds opened
3	G	2.00	I	1 ft. × 3 in.	Still living
4	G	1.25	I	4 ft. × 3 in.	Still living
5	G	0.50	I	Girdled for 2 ft.	Killed as buds opened
6	T	1.00	I	Tree covered	Killed before buds opened
7	T	1.00	I	Tree covered	Killed before buds opened
8	G	4.75	U		Healthy
9	G	5.75	U		Healthy
10	G	4.75	U		Half dead
11	G	3.50	I	1 ft. 4 in. × 3 in.	Still living
12(1)	G	3.50	U		Living
13	G	2.50	U		Living
14	G	4.75	U		Living
15	G	4.75	I	4 ft. × 4 in.	One third dead
16	G	4.25	I	4⅓ ft. × 6 in.	Living
17	G	6.00	U		Living
18	G	7.00	I	5⅓ ft. × 5 in.	Living
19	G	4.75	I	6 ft. × 6 in.	Living
20	G	3.25	U		Living
21	G	5.25	I	5 ft. × 6 in.	Living
22(2)	G	4.25	I	4½ ft. × 5 in.	Partly dead
23	G	6.75	I	3½ ft. × 10 in.	Living
24	G	4.75	I	4½ ft. × 7 in.	Living
25	G	3.75	I	4 ft. × 6 in.	Living
26	G	2.50	U		Dead for some time
27	G	4.75	U		Living

TABLE 1. Continued

Field data on Populus tremuloides and Populus grandidentata

TREE NUMBER	SPECIES*	DIAMETER BREAST HIGH IN INCHES	STATE (U = UNINFECTED I = INFECTED)	SIZE OF CANKER	CONDITION OF TREE JULY 23
28	T	2.25	I	10 ft. × 4 in.	Living
29	T	2.00	I	Girdled for 8 ft.	Killed
30(3)	T	2.00	I	10 ft. × 4 in.	Still living
31	T	1.75	I	8 ft. × 3 in.	Still living
32	G	2.25	I	5½ ft. × 3 in.	Killed as buds opened
33	T	1.75	I	Tree covered	Killed as buds opened
34	T	3.25	I	3 ft. × 3½ in.	Still living
35(4)	T	1.75	U		Sickly with scale
36	T	2.75	U		Sickly with scale
37(5)	G	2.50	I	6 ft. × 4 in.	Almost dead
38	T	1.125	I	2 ft. × 2 in.	Living
39	G	2.25	U		Living
40	T	2.00	U		Living
41	T	1.50	U		Living
42	T	2.25	I	Girdled	Killed before buds opened
43	T	4.75	U		Living
44	T	4.50	U		Living
45	T	2.50	U		Living
46	T	3.50	U		Dead
47	T	5.00	U		Living
48	T	2.50	I	4 ft. 5 in. × 5½ in.	Half dead
49	T	3.50	I	3 ft. × 4 in.	Half dead
50	T	5.00	I	Almost girdled for 5 ft.	Almost dead
51	T	1.00	I	Tree covered	Killed as buds opened
52	T	1.00	I	Tree covered	Killed as buds opened
53	T	1.00	I	Tree covered	Killed as buds opened

TABLE 1. Continued

Field data on Populus tremuloides and Populus grandidentata

TREE NUMBER	SPECIES*	DIAMETER BREAST HIGH IN INCHES	STATE (U = UNINFECTED I = INFECTED)	SIZE OF CANKER	CONDITION OF TREE JULY 23
54	T	1.50	1	Tree covered	Killed when shoots were 2 in.
55	T	1.50	1	Tree covered	Killed when shoots were 1½ in.
56	T	1.50	1	Girdled for 3 ft.	Killed when shoots were 2 in.
57	T	1.00	1	Girdled for 3 ft.	Killed when shoots were 1½ in.
58	T	1.00	1	Girdled for 3 ft.	Killed as catkins opened
59	T	1.50	1	Girdled for 2 ft.	Killed when shoots were 1½ in.
60	T	1.75	1	2 ft. × 3 in.	Sickly, leaves undersized
61	T	2.50	1	Girdled for 3 ft.	Killed when shoots were 2 in.
62	T	1.75	1	Tree covered	Killed when shoots were 1½ in.
63	T	0.50	1	Tree covered	Killed before buds opened
64	T	1.00	1	Tree covered	Killed as catkins opened
65	T	1.00	1	Tree covered	Killed when shoots were 1½ in.
66	T	0.50	1	Tree covered	Killed as catkins opened
67	T	1.25	1	Tree covered	Killed when shoots were 1 in.
68	T	0.75	1	2 ft. × 1 in.	Fair
69	T	0.75	U		Fair
70	T	2.50	U		Poor, covered with scale
71	T	1.50	U		Sickly with scale
72	G	1.00	1	Girdled	Killed before buds opened
73	G	3.50	U		Living

* G = Populus grandidentata, T = P. tremuloides.

(1) Oct. 21, 1920. Two small cankers each 2 in. × ¾ in. Still living.
(2) " Top dead and blown off.
(3) " Dead.
(4) " Dead.
(5) " Dead.

30 trees, or 63.3 per cent were infected and 6 trees, or 20 per cent were killed. It is believed that the higher mortality among the quaking aspens is due to the larger number of younger trees. We note, for example, that 67 per cent of the trees of this species, as compared with 20 per cent of the large-toothed aspens, do not exceed 2 inches in diameter.

DESCRIPTION OF CANKER

On the trunks of small trees and on small branches the canker is very conspicuous because of its color, recalling somewhat the chestnut tree blight. Here the canker appears as a slightly sunken area which is cinnamon to orange cinnamon (5) in color. Thus it is sharply delimited

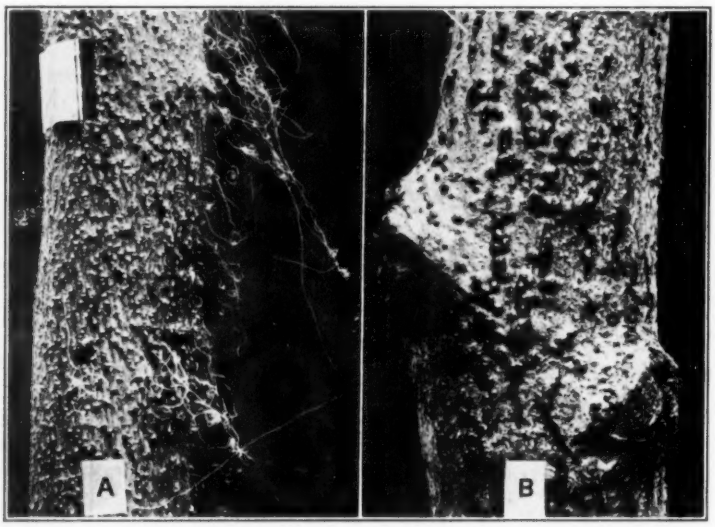

FIG. 2. TWO TYPES OF PYCNIAL EXUDATE
A. Artificial infection on *Populus grandidentata* in laboratory.
B. Natural infection on *Populus grandidentata* from diseased area.

from the grayish olive to deep grayish olive (5) color of the healthy bark. Usually the pustules are surrounded by a narrow (up to 1 mm.) band of the greenish color of the healthy bark. Both types of pycnial exudate, as mentioned by Hubert (2), were found. In the laboratory during wet weather the pycnial hairs become very long. The same result is obtained when material is kept under a bell jar. This is shown in figure 2 A where some of the spore tendrils measure 7 cm. Figure 2 B shows the other type of pycnial exudate in which the pycnospores dry down forming a thin, shining, orange crust and appear as a mound due to the fact that the pycnidia occur in pustules.

On the trunks of large trees the cankers appear as slightly darkened areas, the lateral margins of which are marked by more or less vertical cracks 3 to 12 inches long. These cracks are the result of tension produced by the drying out of the killed bark. When the bark of the cankered area is pressed it collapses against the wood. Often the cracks outlining the limits of the necrotic area appear to be the only external evidence of the disease, although sometimes a closer examination will reveal the presence of tiny spore horns in the deep crevices of the bark.

VALSA SORDIDA NKE.

On the trunk cankers of some of the trees *Valsa sordida* was found. It is suspected that this is the perfect stage of *Cytospora chrysosperma* but inoculation experiments are not yet completed to prove this point. The literature shows disagreement as to the species of Valsa that is connected with *C. chrysosperma*. According to Engler and Prantl (1) and Rabenhorst (4). it is *V. sordida* but both Roumeguère (6) and the Tulasnes (7) give *V. nivea* Fr. This matter can be settled only by careful inoculation experiments.

INOCULATION EXPERIMENTS WITH PYCNOSPORES

Inoculation experiments on poplar cuttings in the laboratory with pycnospores showed the fungus to be a serious wound parasite. Pieces of twigs 4 to 12 inches long and 7 to 21 mm. in diameter were used. The upper end of the cuttings was paraffined to protect the cut surface from infection and to prevent excessive drying. Incisions were made with a sterile scalpel and pycnospores from spore horns applied to the wound. The inoculated cuttings were placed in water in a battery jar which was placed under a bell jar.

Seven cuttings of *P. grandidentata* were inoculated in the manner described above on June 4. Two unwounded stems were placed in the same jar. One twig—incised with a sterile scalpel but not inoculated—was placed in a separate jar. On July 27, as a result of this experiment, 6 of the inoculated cuttings were infected and killed. Figure 2 A shows one of them. The two unwounded cuttings were also infected and killed but the one control remained healthy. Three cuttings of *P. tremuloides*, 11, 12 and 19 mm. in diameter respectively were inoculated in the same manner on the same date. One control (an incision made with a sterile scalpel) was placed with the *P. grandidentata* control. On July 27 the 3 inoculated cuttings were infected and killed while the control remained healthy.

NATURAL INFECTION IN LABORATORY

Ten cuttings of *P. deltoides* Marsh., ranging from 6 to 10 mm. in

diameter, were brought into the laboratory on June 3 and placed in water in a battery jar. These cuttings began to produce roots but in the course of two or three weeks showed signs of disease. A little later (July 1), they developed the characteristic spore horns of *C. chrysosperma* and finally died. These cuttings were not inoculated and came from a healthy tree which grew at least three quarters of a mile from the diseased area. The source of the spores, by which they were infected, was a collection of cankers on *P. grandidentata* which were lying on a table

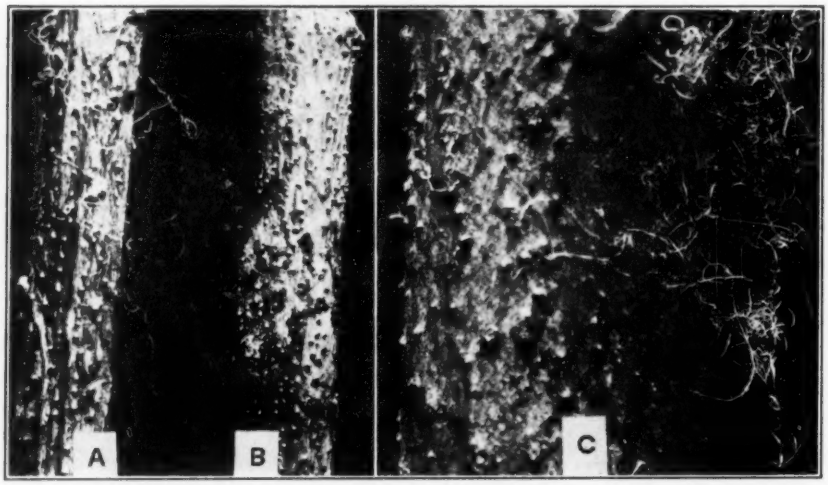

FIG. 3. NATURAL INFECTION ON POPLAR CUTTINGS IN LABORATORY

A. On *Populus deltoides* ($\times \frac{4}{3}$).
B. On *Populus tremuloides*. ($\times \frac{4}{3}$).
C. On *Populus tremuloides*. ($\times 3$).

in the laboratory. It should be mentioned that the tips of these cuttings were not paraffined. Figure 3 A shows the spore horns on one of these dead cuttings. Thirteen out of the 16 cuttings of *P. tremuloides* became infected in the same manner and were killed. Figure 3 B shows one of these slightly enlarged and Figure 3 C shows another three times enlarged to show the great mass of spore material extruded. The tips of these cuttings were paraffined. From the foregoing it can be seen that this disease would prove serious in any nursery where poplar cuttings are grown.

SUMMARY

The poplar canker caused by *Cytospora chrysosperma* (Pers.) Fr., a disease hitherto reported only from the Southwest and Northwest, has

been found near Syracuse, N. Y., attacking poplars weakened by fire.

In the diseased area over 68 per cent of the poplars were infected and over 30 per cent killed.

Valsa sordida Nke., which may prove to be the perfect stage of *C. chrysosperma*, was found on the trunk cankers of several trees.

Inoculation experiments with pycnospores on cuttings of *P. grandidenta* and *P. tremuloides* resulted in infection and death of the cuttings from the disease.

Cuttings of *P. deltoides* and *P. tremuloides* not inoculated but kept in the laboratory where material producing spore horns was exposed became infected and were killed.

Populus grandidentata is a new host for this pathogen.

The writer gratefully acknowledges his indebtedness to Dr. C. C. Forsaith for the photographs for figures 2 and 3. The other illustration is by the author.

DEPARTMENT OF FOREST PATHOLOGY
NEW YORK STATE COLLEGE OF FORESTRY
SYRACUSE, NEW YORK

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BRIEFER ARTICLES

NOTE ON CENANGIUM ABIETIS (PERS.) REHM ON PINUS PONDEROSA LAWS.

JAMES R. WEIR

WITH TWO FIGURES IN THE TEXT

The distribution of this fungus, which has caused serious epidemics in Europe, is not very well known in America, as only a few records of its occurrence exist. A doubtful reference by Schweinitz, occasional mention in fungus and host indices, and a few specimens in various exsiccatae and herbaria comprise its known American history.

HISTORY

Fink (2) reported this fungus as causing the death and mutilation of eastern white pines (*Pinus strobus*) at Oxford, Ohio. This is the first record of the kind in America. The parasitism of the fungus was not established by Fink, and he suggests that probably other causes, such as drouth and a general impoverished condition of the trees, promoted the activities of the fungus, resulting in death. Although the fungus is shown by the observations of Thümen (5), Brunchorst (1), and Schwartz (4) to be parasitic in Europe, it is not generally recognized as a parasite in America. The fact that it frequently follows drouth and winter injury has led to the conception that it is a secondary fungus with weak parasitic tendencies. Hartig (3, p. 86) held that the disease was a result of drouth.

OBSERVATIONS

On an area in the Bitterroot Valley, Montana, what appeared to be this fungus was observed for a number of seasons on young *Pinus ponderosa*. On a smaller area of about one acre in extent, especially selected for study, the affected trees, ranging in age from 4 to 8 years, were either dead or dying when first observed. The symptoms of the disease, viz: reddening of the needles and shrinkage of the bark, were most marked in early spring, from March to June, at which time the needles could be easily shaken off. The reddening of the needles first became evident during the winter, from December to February. The disease apparently started in practically all the trees examined, in an infection at the terminal bud. Since the one-year-old twigs alone were infected,

and in some cases were still partially green, infection must have taken place the previous autumn at the close of the growing season. The disease in but a few instances progressed beyond the one-year-old twig, usually ending abruptly at the internode. On some trees every terminal and lateral shoot was dead with only a few green needles on the inner portions of the branches. Such trees, in most instances, had died be-

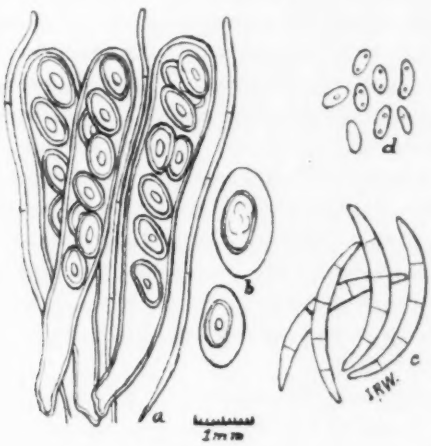

Fig. 1.

Fig. 2.

FIG. 1. SPORES OF CENANGIUM ABIETIS.

a. Asci, ascospores and paraphyses.
b. Ascospores with transparent hygroscopic membrane.
c. Curved septate conidia.
d. Single-celled conidia.

FIG 2. APOTHECIA OF CENANGIUM ABIETIS.

Apothecia on a one-year twig of *Pinus ponderosa*. Photographed by A. S. Rhoads.

fore the end of the growing season. Secondary shoots appeared below the killed portion in some cases, and two 8-year-old trees had apparently thus completely recovered from the disease. The bunched effect of the new shoots gave an appearance of small witches' broom. Two examples, each of nodal and internodal infection, were observed which resulted in the death of the entire branch before the end of the season. That part of the branch beyond the court of infection succumbed more rapidly. The infection in but few cases spread from the terminal shoot into the branches at the upper internode, being checked either by the rapid death of the shoot, or by a very evident resinous impregnation of the bark and wood ahead of the advancing mycelia. This condition was always present in the diseased twigs. The needles first began to

turn red at the point of attachment, later becoming a uniform red color. The twigs were killed rapidly and, late in the autumn, after the fall of the needles or when but few remained, small, black simple or compound pycnidia appeared. These, which agree with the description of *Brunchorstia destruens* Erikss., contained curved 3 to 5 septate spores averaging 23–38 × 3μ (Figure 1, c). Smaller pycnidia, containing simple elongated or elliptical spores measuring 3 × 7μ (Figure 1, d) and which are believed to be the same as those described under the name *Dothichiza ferruginosa* Sacc., were scattered promiscuously among the former. Typical apothecia (Figure 2,) appeared somewhat later. The asci, (Figure 1, a) averaging 9 × 68μ contained 8 hyaline, single celled, elliptical spores with an average dimensions of 4 × 9μ. Under special conditions of preparation, an outer transparent hygroscopic membrane was visible (Figure 1, b). The paraphyses (Figure 1, a) but slightly longer than the asci, were slightly colored, simple, septate, and slightly swollen at the ends. They were mostly confined to the one-year-old twigs and appeared in most cases at the bases of the needle sheaths. The few apothecia observed on older twigs were scattered promiscuously. No fruiting bodies appeared on the needles.

Infection was not uniform throughout the stand, only a tree here and there showing the disease. A count of the reproduction on two acres of typical yellow pine showed an average of 5 per cent infected. The uninfected trees were vigorous and were making the average growth of yellow pine for the site. The dead and infected trees had well developed root systems, and no injuries of any kind, except an occasional healed scar resulting from the tread of grazing animals. There was no tendency toward an epiphytotic condition, nor did the infection during the several seasons it was studied increase or decrease in any degree. Every season a few trees here and there over the area, and otherwise just as vigorous as the uninfected ones, became diseased. The apparent predisposition of certain trees to the disease can not be satisfactorily explained. It is not likely that the condition was caused by an accidental spore distribution.

INOCULATIONS

The conditions on the area just described are more or less typical of the infections by this fungus wherever it has been observed. The observation that the disease was primarily important on reproduction and was apparently parasitic, led to inoculation experiments to determine the latter point. Four branches on as many 6-year-old trees of *Pinus ponderosa* were inoculated with ascospores taken from diseased trees of the same species. The inoculum was inserted both deep within

the bud scales and in incisions just behind the buds, and protected with fine mesh cheese cloth caps. The inoculations were made on September 10, 1914, in the open at Missoula, Montana, some 40 miles distant from any known infections. Three inoculations out of 16 were successful. In February the needles near the buds began to show a slight reddish color. By midsummer all the needles of the previous year's growth on the 3 infected branches turned red. Later they became brown and could be easily shaken from the branch. During September and October 1915, a few fertile pycnidia, containing single-celled spores, appeared and, later, with the advent of the rainy period, the characteristic fertile apothecia of *Cenangium abietis* developed in considerable numbers on the then dead and shrunken twigs. The controls on the same trees remained free from the disease. The infections were confined to the one-year-old twigs and did not extend to the older parts of the branches. Since the immediate region was uninportant from the standpoint of the host the infections were allowed to remain. Two years later 3 other infections were noted in the clump of pines where the original experiments were conducted. In 1919 the place was again visited and but a single diseased twig could be found. The results of a small number of experiments, indicate the parasitic nature of the fungus, and, what is also of great importance, that the fungus does not appear to be aggressively spreading. However, it is capable of doing considerable damage in nurseries and on transplant areas.

Cenangium abietis has been collected on *Pinus ponderosa* in Washington, Oregon and Idaho. It has not been found on any other host.

SUMMARY

Cenangium abietis, the cause of a serious disease on pines in Europe, is here reported for the first time in the western United States on *Pinus ponderosa*. Experiments demonstrate the apparent parasitism of the fungus, a condition not heretofore reported in America.

LABORATORY OF FOREST PATHOLOGY,
BUREAU OF PLANT INDUSTRY,
SPOKANE, WASHINGTON.

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INVESTIGATIONS OF CRONARTIUM RIBICOLA IN 1920

L. H. PENNINGTON, W. H. SNELL, H. H. YORK AND PERLEY SPAULDING[1]

In the Adirondacks Pennington found that aeciospores were produced in greater abundance and were more widely distributed than in the seasons of 1918 and 1919. This was largely if not entirely due to the more favorable weather conditions during the month of May. Successive generations of uredospores were not so well marked as in the seasons of 1918 and 1919. This fact seemed to be correlated with the more even distribution of rainy weather during the summer months. Although telia were produced in considerable abundance during July and August, few viable sporidia could be found prior to the first week in September. A systematic study in many centers of infection to determine the age of individual infections showed that by far the larger number of them dated back to either 1911 or 1915. An examination of the Weather Bureau records showed that these two years were characterized by unusually prolonged rainy periods in the latter part of the summer. These years were also noted as having an unusually heavy infection of late blight and rot of potato. The studies of 1920 brought out very clearly the fact that repeated defoliation of Ribes by *Cronartium ribicola* causes the death of the infected bushes. In some instances *R. cynosbati*, *R. rotundifolium* and *R. glandulosum* were found to be entirely destroyed in the immediate vicinity of heavily infected pine trees. Where this fact is not taken into consideration, errors may be made in determining the distance from Ribes that infection has occurred in pine.

In 1916 Posey found blister rust infection upon wild Ribes bushes upon one of the Isles of Shoals off Portsmouth, New Hampshire. This season Snell reexamined these islands more closely. Three bushes were found infected in early July upon two different islands. The infections were approximately 7 miles distant from the nearest land and somewhat farther from the Kittery Point infection. All 3 infections were on the northwest side of the islands directly facing Kittery Point. Cir-

[1] Papers presented at meeting of American Plant Pest Committee at Boston, Mass., November 5 and 6, 1920.

cumstances were such that it seemed practically certain that the spores had traveled from the mainland to the islands in some manner. Carriage by man does not seem to be probable. It seems that wind carried aeciospores the intervening distance of about 7 miles.

Studies by York were as follows: In 1918 one hundred inoculations were made with each of the 3 spore forms—pycnia, aecia and uredinia on the fresh growth of the season of *Pinus strobus*. The inoculations were made in the axils of the leaves, axils of leaf fascicles, terminal buds, and on the internodes both wounded and unwounded. The results are negative. Various experiments were started in 1917 in a swamp with a heavy growth of *Ribes glandulosum* from which the Ribes were eradicated in mid-summer of 1917. The bushes bore a heavy crop of fruit and much of this fell to the ground when the bushes were pulled. By far the largest number of seedlings appeared in the season of 1918, only a small number having developed since that time. In a plot from which all vegetation was removed, a very large number of Ribes seedlings appeared in 1918. On August 22, 1920, it was found that the number of seedlings which remained in these plots varied from 25 to less than 2 per cent of the original number. In case of the larger number, they were considerably sheltered by a stump. Under the various conditions, varying from the above condition of no competition to that of heavy natural competition with other plants, it was found that a very small percentage of the original number of seedlings survived in 1920. Seedlings of 1918 of *Ribes glandulosum* most favorably situated produced their first fruit in 1920. This was exceptional, however. It appears from these experiments that reeradication of Ribes in such situations will not be necessary as soon as it has been believed, and in some cases may not be necessary for a long time. Many inoculations on pines have been made with the various forms of spores of blister rust, but it is still too early to give any statement as to results.

Investigations by Spaulding are briefly: On Block Island plantings were made several years ago of *Pinus strobus*, *P. flexilis*, *P. cembra*, *P. mugho*, *P. sylvestris* and *P. densiflora*. In the spring of 1920 it was found that every tree of *P. flexilis* was badly infected and all but 2 out of 10 bore fruiting bodies. The remaining 2 certainly will bear fruiting bodies next spring if they are still alive. A considerable number of *P. strobus* have also taken the disease but no other species has shown infection. This limited experience indicates that *P. flexilis* is even more susceptible to the disease than is *P. strobus*. This conclusion is borne out by reports from Europe by Moir. Moir also has found *P. koraiensis* infected by the blister rust in Europe. Inoculations upon Ribes here have produced the disease. At Wilmington, New York, the large

pine planting made to determine the distance that infection spreads from Ribes to pine is beginning to show results (fall 1920). Eight or ten different trees were found plainly showing infections, all extending in a single direction, namely, away from Wilmington Notch, through which the prevailing winds of that section blow. The infection has extended at present only about 30 feet. The white and yellow infected spots on pine needles reported by Clinton and McCormick in their inoculations have been found to be frequent in two different localities where natural infection has occurred. Tubeuf in 1917 published results of inoculations similar to those of Clinton and McCormick in inoculating white pines with sporidia from teliospores. In general they fully confirm the American results but it was found that infection in Tubeuf's experiments took place more in the stem itself than in the needles.

Two points brought out by this year's investigations are especially important. They are that Ribes are often killed in intensive outbreak areas, so that some years later the absence of Ribes in such areas cannot be taken as showing that Ribes have been absent previously. This invalidates numerous conclusions which have been made upon this basis. Second, the numerous cases of breaking of the quarantine in the Mississippi Valley show very plainly that this quarantine must be rigidly enforced or the blister rust certainly will become established west of that line. A single diseased shipment will be sufficient.

Previous conclusions that the aeciospores may be blown an indefinite number of miles and cause infection of Ribes are borne out by this season's work.

PHYTOPATHOLOGICAL NOTES

Chlamydospores of Fomes officinalis in nature.—The references to the occurrence of secondary spores of Hymenomycetes in nature, chiefly upon the fruit bodies, are quite numerous, especially in European mycological literature of the latter part of the past century. Since that time several workers have suggested the possibility of dissemination of wood-destroying fungi by means of these secondary spores—oidia, chlamydospores, conidia, etc. This possibility is as yet unproved and while many of our wood destroyers form secondary spores in agar cultures, such spores occurring naturally have been reported for very few species.

While working at Bald Mountain, Humboldt County, California, in the fall of 1918, the writer found chlamydospores of *Fomes officinalis* formed on rotten wood. A heavy growth of mycelium was noticed upon the sawn end of a Douglas fir badly decayed by *Fomes officinalis*. The mycelium was found not only on the cross section of the bole, but also in rifts within the rotted interior. No opportunity was offered for examination of this mycelium until it was rather old and had been frosted several times. At that time the mycelium and what appeared to be chlamydospores were not in good condition. Material from this tree was cultured on malt agar in connection with investigations being carried on at that time and examination of these cultures later showed an abunbance of chlamydospores resembling those described by Faull[1] from his cultures. These chlamydospores were found to germinate readily.

In the summer of 1919, at the request of the writer, Dr. A. S. Rhoads sent two specimens of wood of two trees of *Pinus ponderosa* badly decayed by *F. officinalis* from Massack, Plumas County, California. These were examined in the fall at Madison, Wisconsin. Chlamydospores were found in the loose mycelium growing on the surface of the pieces of rotted wood and in the cracks, but not in the thick mycelial mats which are commonly present. Attempts to germinate the spores were unsuccessful, perhaps because of prolonged drying, as the material was not examined until four months after it had been received. As far as can be

[1] Faull, J. H. Fomes officinalis (Vill), a timber destroying fungus. Trans. Roy. Canad. Inst., **11**: 185–209. *8 pls.* 1916.

ascertained, the finding of the chlamydospores upon the vegetative mycelium in nature has not previously been reported.

These chlamydospores are similar to those found in culture. They are colorless, globoid to ellipsoid (or fusiform according to Faull), the latter usually with papillate apex and truncate base. Their size is variable, the limits being 5.5–9 × 5.5–9μ. The contents are granular

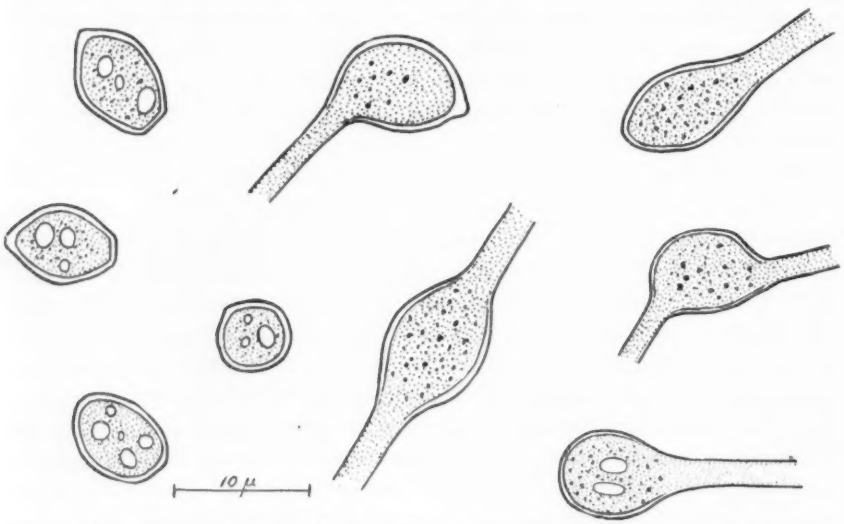

FIG. 1. CHLAMYDOSPORES AND HYPHAL SWELLINGS OF FOMES OFFICINALIS FOUND IN BADLY DECAYED WOOD OF PINUS PONDEROSA.

and oil globules are common. They occur singly and terminally. Terminal and intercalary swellings of the hyphae are common (Figure 1), but nothing was observed to show that the intercalary swellings matured to chlamydospores.

In addition to the chlamydospores occurring in cultures of *F. officinalis*, Faull also reports finding chlamydospores in the crust of all the fruit bodies of this fungus which he examined. These latter, however, are different in size, shape, color, and formation from those formed in culture. They are described by Faull (p. 201) as formed in chains by further septation of the septate hyphae, with or without enlargement, followed by a thickening of the walls. They measure 2–7 × 2–6μ, are "irregularly spherical to elongated and in color from hyaline to yellowish brown," the latter color appearing as the spores mature.

Faull expressed the belief that the chlamydospores in the fruit bodies are a means of propagating the fungus. While the chlamydospores found upon the wood were not germinated, it seems reasonable to assume

that fresh chlamydospores would be viable, inasmuch as they are apparently identical with those developed in cultures, and that propagation of this fungus in nature by means of its chlamydospores is possible.—WALTER H. SNELL.

A chisel forceps. Difficulties are encountered with scalpel and forceps in preparing fragments of infected wood for culturing on artificial media. The thin handle of the scalpel is objectionable when considerable pressure is needed to pry the fragments loose. Some difficulty is also experienced in transferring the fragment to the media containers. Interchanging the scalpel for the forceps is an interrupted operation and requires additional time for sterilization. One objection to the interrupted operation is the additional time during which contamination can take place. The instrument, (Fig. 1) described below, with cutting edge and forceps combined, is designed to replace the ordinary scalpel and forceps for this type of work.

FIG. 1. A CHISEL FORCEPS.

The chisel forceps is made by soldering or brazing to the flat side of the shank (Fig. 1 A) of a good grade of wood-cutting chisel a strip of spring metal (Fig. 1 B) to which is attached a metal rod about 5¾ inches long flattened at the free end (Fig. 1, C). The chisel is about 8½ inches long and has a ¼ inch cutting edge. The wooden handle of the chisel is replaced by a short rounded wooden plug which gives a good surface for applying pressure with the palm of the hand.

The instrument grasped in the right hand is first sterilized by dipping in alcohol and flaming, the chisel point is then forced into the infected wood, a fragment is pried loose, is then grasped between the chisel point and the movable arm and transferred to the medium within the glass container where it is easily plunged to the required depth at the desired spot in one operation.

This instrument can be constructed to meet the special needs of other phases of plant pathology. A wood-carver's gouge with a ⅛ inch cutting edge or some other tool substituted for the chisel would prove useful in detaching fragments of inoculum from diseased tissues of potato, cabbage, carrot, and other crop plants.—ERNEST E. HUBERT.

Polyporus schweinitzii Fr. on Thuja plicata. The heart wood of *Thuja plicata* (western red cedar) is subject to three common and distinct types of decay, all of which are of economic importance. A uniform light yellow or brown, laminated, carbonizing trunk and butt rot caused by *Poria weirii* Murrill, is very common throughout the range of the tree. A dark brown, crumbly, carbonizing, pocket, and ring rot is also very common and destructive, but has never been definitely connected with any known wood destroying fungus. It has been incorrectly referred to *Polyporus schweinitzii.* A uniform, brown, carbonizing butt rot breaking up into rectangular blocks has been attributed to *Polyporus schweinitzii* by various observers, but sporophores have never been reported as associated with this decay. Recently a single specimen of *Polyporus schweinitzii* Fr. was found associated with its typical decay in a root of western red cedar near Priest Lake, Kaniksu National Forest, Idaho. The brown, cubical, carbonizing rot of this fungus was uniform throughout the heart wood of the base of the tree, and extended upward for a distance of about four feet. The sporophore had its origin directly in the diseased wood. This wood after exposure produced the mycelium of this fungus. This is the first authentic record of the collection of a sporophore of this fungus associated with its decay on western red cedar.

The lighter color of the decayed wood, its uniformity throughout the affected area, absence of any tendency to form pockets or streaks, and the large size of the individual cubes of decayed wood, makes it doubtful if *Polyporus schweinitzii* is the cause of the unknown, brown, pocket rot above mentioned. The appearance of the latter is very similar to the decay caused by *Polyporus amarus* Hedgcock in *Libocedrus decurrens,* but sporophores of this species have not been found on western red cedar. In view of this fact, and the rarity of *Polyporus schweinitzii* on cedar, it is believed the identity of the common brown pocket rot in this tree is as yet undetermined.

Fomes pini (Thore) Lloyd attacks the western red cedar on isolated areas, but it is not a common cause of decay. *Fomes annosus* Fr., *Polyporus sulphureus* (Bull.) Fr. and *Armillaria mellea* Vahl occasionally attack the living tree, but with the exception of the last named species, which also attacks and kills young trees, they are not of much economic importance as regards the destruction of merchantable timber.—JAMES R. WEIR.

The age of brown-rot mummies and the production of apothecia. It has been supposed generally that the ascogenous stage of the American form of the brown-rot fungus (*Sclerotinia cinerea*) affecting peaches, plums and other stone fruits does not appear except on mummied fruits

which are more than one year old, but in the spring of 1921, the writer obtained apothecia from mummied fruits of the 1920 crop of both plums and peaches. During the summer of 1920, plums and peaches affected with brown-rot were collected and placed on the ground in a situation remote from plum and peach trees. The diseased fruits were of the current year's crop, great care being used to select only those which were still plump and juicy in order to avoid any chance of selecting a mummied fruit of a previous year. The rotting fruits were placed on the ground in a shaded situation where there was no chance of other decayed fruits being present. In all eight hundred plums and seventy-five peaches were used in the experiment. In March, 1921, forty of the plums and five of the peaches were found to be producing apothecia, varying in number from three to twenty-one for each fruit. Morphologically these apothecia agreed in every way with those of the American form of *Sclerotinia cinerea*. Cultures from single spores produced typical mycelium and spores and could not be told from stock cultures of the American form of the brown-rot fungus.—JOHN W. ROBERTS.

Summer field meeting of cereal pathologists. Plans for the forthcoming summer field meeting of cereal pathologists and others interested in cereal crop improvement have been completed. Accordingly it has been arranged to call the meeting at University Farm, St. Paul, Minn., and the following itinerary has been announced:

Tuesday, July 19—Meet at University Farm.

Wednesday, July 20—Trip through environs of Minneapolis and St. Paul. Lunch at the Fruit Farm near Lake Minnetonka.

Thursday, July 21—Minneapolis: visiting flour mills and grain elevators; field trip near Twin Cities; laboratory and nursery inspection at University Farm. Leave Minneapolis for Fargo N. D.

Friday, July 22—Visit College Farm and laboratories. Field trip in vicinity of Fargo.

Invitations have been sent to several European, South American, and other foreign plant pathologists, and it is anticipated that the meeting will be the most representative of all the summer cereal field conferences yet held in the United States. Those planning to attend this meeting are requested to notify Dr. E. M. Freeman, University Farm, St. Paul, Minn.

Personals. Dr. D. Atanasoff, formerly graduate student at the University of Wisconsin, after spending a year at the Biologische Anstalt, Dahlem and at other institutions in Germany has accepted a position in the laboratory of Prof. Dr. H. M. Quanjer of the Phytopathological Institut at Wageningen, Holland.

THE COOPERATIVE POTATO SPRAYING PROJECT: PROGRESS REPORT FOR 1918, 1919, AND 1920.

G. R. Bisby

The cooperative potato spraying project is one of the problems for cooperative work undertaken by American plant pathologists under the auspices of their War Emergency Board and Advisory Board. The general leadership of this project, and the responsibility for this report, has been assumed by G. R. Bisby, Agricultural College, Winnipeg, Canada (Formerly at the Minnesota Agricultural Experiment Station).

Bordeaux mixture is commonly applied to potatoes in regions in which late blight occurs or threatens each year. Increased yields result in some areas even when late blight is absent. For many regions, however, plant pathologists do not know just what recommendations to make to potato growers regarding the use of Bordeaux mixture and other fungicides.

The War Emergency Board of American Plant Pathologists considered it important that cooperative work be undertaken on a potato spraying project, and the writer was asked in the latter part of June, 1918, to serve as leader. Letters were at once sent out to pathologists in order to place the proposition before them, with inquiries as to past results of spraying potatoes, and a request for suggestions. Considerable information was received in response to these letters.

The Advisory Board of Pathologists decided that this project, lying between experimentation and demonstration, was a favorable one for continued cooperative effort. G. R. Lyman called a meeting of interested pathologists at Chicago on February 15th, 1919, and the spraying project, among others, was discussed. It was decided to draw up a definite field experiment, with the use of standard equipment, spray materials, and methods of application, with a view of obtaining comparable results and an idea of the optimum spraying schedule in the various localities. This field plan, devised largely by C. R. Orton, is partially given below, and was submitted in 1919 to various workers for their reference, although it was realized that few would be able to undertake the full project.

Early in 1920, this project was again brought to the attention of many of the pathologists. With the beginning of 1921, it was decided to publish this report of the work that had been done by those cooperating.

It was considered worth while also to include a brief summary of the present status of spraying throughout the United States and Canada. A summary for each state and province was accordingly submitted to the proper worker with a request that he correct or amplify the statement as applying to his region. This report is, therefore, a review of the problem for many regions, and includes considerable new data that several have been able to add. The greatest credit is due to the various pathologists and others for the generous way in which they have contributed data for the summary, and for the hearty cooperation that practically every worker has manifested in this project. The leader has endeavored to function merely in providing a clearing house for the scattered results. Thanks are due to Messrs. G. R. Lyman, E. C. Stakman, and C. R. Orton for ideas and help of various kinds.

PLANS OF THE PROJECT

The necessity for working in cooperation with the entomologists in potato spraying work is becoming more evident. Leaf hoppers and aphids are now known to cause or to transmit diseases, and the control of the flea beetle by Bordeaux mixture is also of interest to entomologists. The use of the principles developed by agronomists in field technic must be taken into consideration, in the provision of sufficient checks and replications as well as the use of uniform fields and methods. Experiments in commercial fields are particularly valuable in that larger areas can usually be sprayed, and practical grower's equipment and conditions can be taken into consideration. Sufficient checks should, of course, be left, and these arranged so as to give comparable results, e. g., eight rows sprayed, then four rows left unsprayed, rather than one acre sprayed and another acre left unsprayed. Experimental spraying on a small scale is, of course, valuable, and can often be used to advantage in deciding local questions.

The potato spraying project was brought to the attention of the workers during the three years by letters inquiring as to whether opportunity or need existed for testing out the effect of Bordeaux mixture with the suggestion that such results as were secured might be rendered of added value by comparison with other data from similar regions or under similar conditions. No attempt was made to dictate what should be done, and even excessive "organization" of the project was avoided. An outline of the field experiment previously mentioned was, however, sent out for reference in 1919 and 1920, including the recommendations that standard machines capable of maintaining high and uniform pressure be used. A 4–4–50 Bordeaux mixture was suggested, made as follows: fill the tank one-third full of water; add the required

amount of stock solution of lime; fill the tank two-thirds full of water to mix the lime thoroughly; add required amount of stock solution of copper sulphate; and fill the tank with water. This is economical of time and labor unless special elevated tanks have been rigged up for the purpose. Arsenate of lead or other poison should be applied to each plot upon the first appearance of biting and chewing insects.

An outline for the taking of field data was submitted, including records of soil type, dates of planting and spraying, occurrence of diseases and insects with dates and prevalence, pressure used, yield, costs, etc. It was noted that the field might be of any size; but an acre field was suggested, 360 feet by 121 feet. The field might be divided into 30 plots, each plot consisting of 4 rows of potatoes (see table 1). The letters indicate the time each plot is to receive a particular spray; e. g., A—1st spray, E—5th spray, etc. It was suggested that the plots be sprayed at regular intervals beginning when plants were 5 inches high, and repeating every 10 days. It was recommended for experimental purposes that as many applications be made as the season might permit. Plots 5, 11, 17 and 23 are checks to receive only poison for insects. Various plots should indicate the importance of spraying in different parts of the season.

In many cases, it would not be necessary to apply the ten sprays listed on the field plan; and the sprays J, I, etc. could be omitted without affecting the general value of the plan.

The following reports on the status of the use of Bordeaux mixture in the various states and provinces are listed by regions. Where publication of results has been made, a very brief summary is included—the references to bulletin numbers referring to the bulletins of the agricultural experiment station in question. The imperial gallon, used in Canada, is ¼ larger than the U. S. gallon; a Canadian reference to 4–4–40 Bordeaux should be interpreted 4–4–50 in the United States.

SUMMARY OF RESULTS AND STATUS OF THE USE OF BORDEAUX MIXTURE ON POTATOES

Canada: Work of the Dominion Department of Agriculture in Eastern Canada.—G. E. Sanders and his co-workers, particularly A. Kelsall, have recently developed in Nova Scotia a copper dust. They have tried out the "5-2" formula on potatoes, the figures referring to the percentage of metallic copper and metallic arsenic respectively. Twenty pounds of copper sulphate, dehydrated and ground fine, forming 12½ lbs. powder; 7½ lbs. dry arsenate of lime, containing 40 per cent As_2O_5, and 80 lbs. of hydrated lime are mixed. This dust was found to stick well, and when moisture strikes the leaf, a blue Bordeaux is produced. At Fredericton, N. B., the dusted plot yielded 396 bu. per acre; 4–4–40 (4–4–50, U. S. gallon) Bordeaux, 407 bu.; check, 238 bu. At Truro, N. S., dust, 744 bu. per acre; Bordeaux plus poison, 652 bu.; check, 550 bu. (Proc. Ent. Soc. Nova Scotia, **1918:** 32–37, 1919). Their report for 1919 (l. c. **1919:**

TABLE 1.

Plan of Field

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
			A		A	A	A	A	A		A	A	A	A															
					B	B	B	B	B		B	B	B	B	B											B			
C			C			C	C	C	C		C	C	C	C	C		C												
D	D						D	D	D		D	D	D	D	D		D	D								D			
E	E	E	E					E	E		E	E	E	E	E		E	E	E								E	E	E
F	F	F							F		F	F	F	F	F		F	F	F	F						F	F	F	F
			G								G	G	G	G	G		G	G	G	G	G							G	G
												H	H	H	H		H	H	H	H	H		H			H			H
			I										I	I	I		I	I	I	I	I		I	I					
														J	J		J	J	J	J	J		J	J	J	J			

77–94, 1920) gives further results. The yields of potatoes obtained in 1919 average somewhat less from dust than from Bordeaux, but insects well controlled by dust. Late blight control not perfect if less than 5 per cent of metallic copper is used in the dust. Some evidence that the "stimulating effect" of the dust on the plant is greater than that from Bordeaux. Sanders and Brittain consider (Proc. Ent. Soc. N. S., **1916:** 55–64, 1917), that arsenic compounds have their efficiency reduced when added to Bordeaux; but that sodium compounds increase the effectiveness of poison, perhaps by rendering the leaves more appetizing to insects. Sanders and Kelsall recommend equal parts of $CuSO_4$ and lime in wet Bordeaux for potatoes; but find a mixture containing 3 to 5 times as much lime as copper valuable for apple (l. c., **1918:** 69–75. 1919; see also pp. 51–61). Other observations by the same workers in Agr. Gaz. Can. **7:** 10–12, 1920, and Proc. Ent. Soc. N. S., **1919:** 21–33. 1920.

Wm. Blair reported in 1892 some average increase at Nappan, N. S., from spraying potatoes with about a 3–2–11 Bordeaux. (Canada Cent. Exp. Farm. Report **1892:** 187). Other data in the reports for **1893**, p. 222, and for **1900**, p. 335. W. T. Macoun reports (l. c. **1904:** 131–132; Bull. 49) an increase of 92½ bu. per acre as a result of 4 and 5 applications of Bordeaux at Ottawa in 1901, 1902, and 1904. He also found (l. c. **1905:** 111–121) Burgundy mixture 6–7½–40 did not injure potato leaves; but that the results were hardly as good as from Bordeaux. Other data in the Central Exp. Farm Reports **1892:** 161–164; **1908:** 126; **1910:** 251–284; **1916:** 1147–1149.

H. T. Güssow writes that the Dominion Department of Agriculture has for some years been devoting efforts to bring about the general use of thorough spraying in the Maritime Provinces and in Quebec.

Prince Edward Island.—Late blight common. P. A. Murphy reported (Can. Dept. of Agr., Circ. 10, 1916; Agr. Gaz., Can. **4:** 942, 1917) 97 bu. per acre increase from 5 applications of Bordeaux in 1915. In 1916, no increase in yield from spraying; but rot much reduced. T. Ross reported (Agr. Gaz., Can. **2:** 334, 1915) about half the growers used Bordeaux. G. O. Madden writes that there is no data as to the effect of Bordeaux when late blight is absent.

Nova Scotia.—Late blight common, first appearing after 1877. Scarcely any of the larger growers now attempt to grow the crop without spraying (R. L. Fuller, Agr. Gaz., Can. **2:** 334, 1915). See data previously given.

New Brunswick.—Faithful use of Bordeaux necessary. (J. B. Daggett, Agr. Gaz., Can. **2:** 334, 1915). B. Baribeau writes that he has no data as to the value of Bordeaux in the absence of late blight. See also data previously given.

Maine.—W. J. Morse reports late blight usually present, often serious. Early blight and tipburn common, more particularly in the southern part of the state. Tipburn apparently physiological. Necessity of spraying with Bordeaux abundantly proved (Me. Bulls., 73, 87, 98, 112, 149, 164, 169). Iron sulphate decreases yield (Bull. 236). Bordeaux quite effective as a repellant against flea beetle (Bull. 211). Prepared or hydrated lime found satisfactory (Bull. 98).

New Hampshire.—Late blight common, tipburn common, early blight not serious. Bordeaux pays. O. R. Butler reports ratio of copper sulphate to lime must be about 1: ½ if satisfactory adhesiveness is to be obtained. An 8-4-50 Bordeaux applied every two weeks gave superior protection to a 4-4-50 mixture applied weekly in 1919. (See Pl. Dis. Bull. Suppl. 10, 1920. N. H. Sta. Circular 22, 1920; Phytopath. **4:** 125, 1914 and **9:** 431, 1919, N. H. Bull. 192, 1919 and Circ. 15, 1914, for physical and chemical studies). Bulls. 22, 27, and 45, by H. H. Lamson, dealt with increased yield from spraying.

Vermont.—B. F. Lutman writes that the potato crop in Vermont can be increased 15 to 25 per cent, in the absence of late blight, by keeping the plants covered with Bor-

deaux from early July for two months, necessitating at least four sprayings. Results more pronounced on late than on early potatoes. Bulletin 159 summarizes results of twenty years spraying, begun by L. R. Jones, during which an average of 105 bu. per acre increase was obtained. See also Bulletins 24, 40, and Annual Reports 9, 15, 16, 17, 18. Bulletins 196 and 214 and Potato Magazine, July, 1918, give further data, especially effect on leaves, on tipburn, etc. Advantage of spraying thoroughly established.

Massachusetts.—A. V. Osmun reports that 4-4-50 Bordeaux for early applications, and 5-5-50 for later sprayings give good results in control of late blight. Carefully conducted experiments in potato spraying have not been performed. Bordeaux is recommended to, and commonly used by, growers.

Rhode Island.—Director B. L. Hartwell reports published discussion of Bordeaux for potatoes in Bulletin 38, 1896, and in third Annual Report of Station, 1890, and results of tests given in Bulletin 111, 1906. Bulletin 111 gives a comparison of varieties as to resistance to late blight, and effect on some fifty varieties from spraying five as compared with four times.

Since 1905, various unpublished data have accumulated, which were kindly submitted by Director Hartwell, and are here briefly summarized. In 1906, about seventy-five varieties of potatoes were grown, half the rows sprayed five times with Bordeaux, half with insecticide only. The varieties were classified into two groups, higher yielding and lower yielding; the former averaged 254.7 bu. per acre where sprayed, 160.1 bu. per acre without Bordeaux; the latter 144.1 and 97.3 respectively, Late blight present; but appearance was retarded on sprayed areas, and late varieties in general showed the disease later than did the early varieties. New Queen potatoes also planted at different dates and left unsprayed to see if degree of maturity had any influence in the time of appearance or severity of late blight. Results as follows:

TABLE 2.

Effect of maturity on late blight attacks

DATE OF PLANTING	YIELD ON SEPT. 17	PERCENTAGE OF FOLIAGE ATTACKED BY LATE BLIGHT			
		JULY 31	AUG. 2	AUG. 4	AUG. 9
Apr. 28	188 bu.	10	20	75	90
May 5	153 "	10	20	75	95
" 12	147 "	10	20	70	85
" 19	104 "	3	10	60	85
" 26	91 "	2	5	55	80
June 2	35 "	1	5	50	85

New Queen potatoes sprayed twice with Bordeaux yielded 222 bu. per acre; sprayed four times, 241 and 239 in two plots; not sprayed, 122 and 98 bu. per acre.

In 1907, about seventy-five varieties grown as before, but late blight almost absent. Four sprayings with Bordeaux nevertheless gave 15 per cent increase in yield of potatoes over two ounces. Over six hundred varieties from J. R. Lawrence, East Rayntham, Mass., grown without spraying to test resistance to blight; but no progress because of absence of the disease.

In 1908, about four hundred and seventy-five varieties planted on April 29th and 30th, and dates recorded on which leaves had turned brown entirely because of blight. By August 28th, only the varieties, Arabella, Fidelio, Gov. Folk, Prof. Wohltman

Scottish Triumph, Scott's No. 8, No. 10, and No. 43, Table Talk, The Bruce, Violette au Claire, Warrior, and Queen were not entirely brown. Although certain of the varieties yielded over 250 bu. per acre, Table Talk (123 bu.) and Warrior (97 bu.) were the only ones of the above list which yielded over 60 bu. per acre.

In 1909, only about fifty of the varieties were planted, many having been discarded on account of the small yields. An estimate was recorded of the percentage of blight on August 20th. Those varieties then showing less than 10 per cent of blight, together with their total yields of potatoes at harvest time were as follows: Epitomist Bolgiani, 87 bu., Ensign Bagley, 140 bu., Wild Potato from Mexico, 28 bu., Geante Blanche, 165 bu., Junior Pride, 68 bu., Old Hemlock, 78 bu., Pearl of Savoy 61 bu., Pat's Choice, 131 bu., Piqua Chief, 95 bu., Purple King, 30 bu., Richter's Imperator, 19 bu., Rural Blush, 181 bu., Uncle Sam, 85 bu., White Flyer, 209 bu., Whitten's White Mammoth, 168 bu., and Violet, 70 bu. The maximum yields were of McCormack, 303 bu. (15 per cent of blight) and World's Fair, 353 bu. (10 per cent of blight). At least 90 per cent of blight was recorded on August 20th, on the following varieties: Daisy, Merrill, Orguil du Marche, Presbey's 66, Sport of Admiral Foote, and Scotch Rose.

There is no record that the work on selection of blight-resistant varieties was continued later than 1909.

Other observations as follows: in 1906, application of dust Bordeaux, wet, gave a yield of 139 bu. per acre; dust Bordeaux, dry, 165 bu., regular Bordeaux, 234 bu., and without fungicide, 124 bu. In 1914, "Bug Death" applied, 169 bu. per acre, Bordeaux, 175 bu. In 1916, nearly twelve inches of rain in July. With Insecticide and two or three sprayings with Bordeaux, 74 bu. per acre, with Insecticide and about ten applications of Bordeaux, 106 bu. In 1917, Insecticide only, 293 bu. per acre; Insecticide and Bordeaux, 295 bu. per acre. In 1918, Insecticide and two or three applications of Bordeaux, 302 bu. per acre; with Insecticide and about ten sprayings with Bordeaux, 301 bu. per acre. In 1919, blight could not be controlled because of a total of sixteen inches of rain in August and September.

While in certain years no particular increase has occurred, it is evident that the application of Bordeaux in Rhode Island pays with late potatoes because of the danger from late blight and the increase in yield usually resulting from spraying. Many growers believe, however, that spraying is less necessary with the Irish Cobbler type.

Connecticut.—G. P. Clinton has published (Ann. Rep. **1915:** 487, 1916) thirteen years' results in which an average increase from spraying of 38 bu. per acre was obtained in various experiments. Average in blight-free years, 29 bushels increase. Results for 1916 in Ann. Rep. for **1916:** 355–364, 1917; and later results under growers conditions in which less favorable results were obtained are given in bulletin 214, 1919. Clinton reports, "On the whole, farmers in this state have not made a practice of spraying for blight, partly because there are no districts devoted largely to potato growing. Summing up experience for past sixteen years: (1) It certainly does not pay to spray early potatoes. (2) If I were growing late potatoes as a special crop, I would practice spraying, although on the average they do not suffer severely from blight once in five years." Dr. Clinton also considers that spraying might be more advantageous in northern Connecticut. He finds home-made 4-4-50 Bordeaux better than Pickering's solution, or than barium water Bordeaux. Spraying is not likely to become general in Connecticut. In dry years, yield of sprayed fields is sometimes reduced by trampling of vines. Better results from three or four thorough hand sprayings than from power machines going over fields six or seven times. The latter is the more common practice, however.

Quebec.—Late blight common. Bordeaux tested in 1919 in 6 fields in Pontiac County

gave average increases of 60 bu. per acre from 4 sprayings; in 1920, 3 fields sprayed 5 times gave average increases of 150 bu. per acre, and rot was greatly lessened (C. H. Hodge, Agr. Gaz. Can., **7:** 959, 1920). Tests in 60 fields in 40 counties gave an average of 35 per cent greater yield from poisoned Bordeaux than from poison alone in 1919 (G. Maheux, Que. Soc. Prot. Plants Ann. Rep. **12:** 43–46, 1920).

Ontario.—C. A. Zavitz reports (Bull. 239) an average increase of 18.7 bu. per acre from 18 tests during 3 years from spraying the tops and bottoms of the leaves 3 times with Bordeaux. Late blight rot was quite serious 5 years, somewhat troublesome 5 years, and practically absent 16 years during 26 years at Guelph. Bordeaux decreased amount of rot in the crop. Relative resistance of potato varieties to rot given. Prof. J. E. Howitt reports Bordeaux recommended, and progressive growers spray each year with apparently good results even in absence of blight on account of preventing tipburn and increasing or lengthening the growth of the plants. Results obtained at Ottawa by Dominion workers previously mentioned.

New York, Geneva Station.—F. C. Stewart and co-workers have fully demonstrated the value of spraying in New York as a preventive of late blight, and they find spraying pays in the absence of late blight by lessening flea beetle and tipburn injury. Lime sulphur injurious. See bulletins 123, 221, 241, 264, 267, 279, 290, 307, 311, 323, 338, 349, 379, 397, 405, 421. Experiments for ten years at Geneva and Riverhead, and many farmers' tests, gave average increases of from 25 to 97.5 bu. per acre from spraying (Bull. 349).

New York, Cornell Station.—The Extension Department has carried on potato spraying demonstrations in a total of forty-two fields in Allegany, Cortland, Erie, Fulton, Monroe, Nassau, Oneida, Ontario, Otsego, and Steuben counties in 1918 and 1919. For these two years Chupp reports the average yield of the sprayed fields was 240 bu. per acre, of the unsprayed fields 190 bu. per acre. In 1918, no blight occurred; yet an average of twenty-eight fields in seven counties gave an increase of about thirty bushels per acre from applying Bordeaux under growers conditions. In 1920, Bordeaux applied to 57 fields in 11 counties gave an average yield of 277 bu. per acre; the checks yielded 206 bu. per acre. Late blight severe. The Department is also trying the effect of dusting with Sander's copper-lime dust. On the average, as good results were obtained during 1920 in yield and in control of blight as were obtained from Bordeaux sprayed rows.

New Jersey.—Late blight absent 1913 to 1917, present 1918 to 1920; early blight rather serious, tipburn common. H. C. Lint (Ann. Reps. 1915 and 1916) reported good results from Bordeaux. Sulphur dust he found of less value than Bordeaux. M. T. Cook (Circ. 105) reported six year's results in which the effect of Bordeaux on Cobblers and Giants varied. During 1919 and 1920, W. H. Martin performed experiments. Fom his data, the following brief summary is made. In 1919, main crop Cobblers grown in Salem Co. were sprayed five times with a traction sprayer. No late blight, but considerable early blight and tipburn. Plants began to die on July 7th. By July 22nd, an average of 89 per cent of the leaves were dead on the check plots, but only 44 per cent were dead on the 5-5-50 Bordeaux plot, and 27 per cent on the commercial zinc-Bordeaux plot. The latter spray was made up to about the strength of the home-made Bordeaux. Checks sprayed with lead arsenate. Average yield of three Bordeaux plots, 265.4 bu. per acre; of three zinc-Bordeaux plots, 268.6 bu. per acre; of four checks, 216.0 bu. per acre. Increase from spraying in the absence of late blight, about 50 bu. per acre. Late crop Cobblers planted July 1st, on level loam field in Salem Co. were sprayed September 12th, 19th, 29th and October 9th with traction sprayer giving 150 lbs. pressure, three nozzles to row. Check plots unsprayed. Late blight

first observed in check plot Sept. 29th; and by Oct. 9th, 75 per cent of the leaves in the check plots were infected with late blight, while by Oct. 21st, only 3 per cent of the leaves were dead on the sprayed plots. Unsprayed plots ranged from 120.7 to 140.9 bu. per acre, with an average for ten plots of 132.7 bu. per acre; sprayed plots ranged from 172.2 to 196.2 bu. per acre, with an average for nine plots of 183.4 bu. per acre, an increase of about 50 bu. per acre for late crop Cobblers in the presence of late blight. In 1919, main crop American Giants in Monmouth Co. were sprayed four and five times, some at 150 and some at 250 lbs. pressure, with 5-5-50 Bordeaux, the checks being sprayed with lead arsenate. Some early blight and tipburn present. Six check plots gave an average yield of 258.7 bu. per acre; three interspersed Bordeaux plots sprayed four times gave an average of 239.4 bu. per acre, an average loss of 19.3 bu. per acre from spraying. In another series, three plots sprayed five times with Bordeaux at 150 lbs. pressure gave an average yield of 215.2 bu. per acre; six corresponding checks, an average of 269.9 bu. per acre, a loss of 54.7 bu. per acre from spraying. Three plots sprayed five times at 250 lbs. pressure gave an average yield of 226.2 bu. per acre; six corresponding checks averaging 255.6 bu. per acre, a loss of 29.4 bu. per acre from the use of Bordeaux on American Giants. No late blight on the Giants. In 1920, Giant variety (main crop) in Middlesex Co., sprayed six times with 5-5-50 Bordeaux applied with three nozzles per row at 150 lbs. pressure gave an average yield of 246.6 bu. per acre; lead arsenate checks yielded 261.7 bu per acre. Late crop Giants in Salem Co. similarly sprayed with Bordeaux five times yielded 178.0 bu. per acre; unsprayed check 150.4. Late blight present: on October 18th, 62 per cent of leaves dead on check plots, 10 per cent on sprayed plots. Main crops Cobblers in Salem Co. sprayed five times gave yield of 281.8 bu. per acre with 5-5-50 Bordeaux, 226.0 bu. per acre with 4-4-50, and 260.3 bu. per acre on lead arsenate check. No late blight. Late crop Cobblers in Salem Co. sprayed five times yielded 199.3 bu. per acre; unsprayed check 163.9 bu. per acre, arsenate of lead check 175.2 bu. per acre. On October 18th, 92.5 per cent of the leaves dead on check, 9.0 per cent on 5-5-50 Bordeaux plot, 68.0 per cent on arsenate of lead plot. Most of this dying from early blight and tipburn, though considerable late blight was present.

It evidently pays to spray Cobblers in New Jersey, but not Giants, except in the case of the late crop which may suffer from late blight. Actual decrease in yield from spraying main crop Giants.

Pennsylvania.—C. R. Orton has helped greatly with the cooperative spraying project, supplying many ideas, and with E. L. Nixon through the Extension Service of the Pennsylvania State College has obtained a mass of data as to the value of spraying in Pennsylvania. Late blight sometimes present, early blight and tipburn rather serious. Remarkable increases from Bordeaux even in absence of late blight (See Pot. Mag., Jan., 1920). In 1918, thirty-two demonstrations of spraying were held in twelve counties, a total of 314 acres being sprayed an average of five times at an average cost of $8.65 per acre, and resulted in an average increase of 34.8 bu. per acre. In 1919, 224 demonstrations were held in twenty-three counties, spraying a total of 1,787 acres an average of 5 times with an average increase of 42.9 bu. per acre, worth in 1919 $58.50, at a cost of $9.00 per acre. In 1920, spraying was carried on on 318 farms in forty-two counties on a total of 6,193 acres with an average increase of 74.7 bushels per acre obtained.

In 1919, the project as previously outlined was performed in two places. At State College, the average of the plots sprayed six times with Bordeaux and insecticide was 152.6 bu. per acre; those sprayed with insecticide only 122.5 bu. per acre, a gain of 30 bu. per acre. Early blight was unusually severe, tipburn present but not severe

until about September 1st, late blight became epidemic and destroyed about 50 per cent of the plants in unsprayed plots. Later applications of Bordeaux more valuable than earlier because of occurrence of late blight. At State College, another field was sprayed four times when it was thought to be advantageous to the plants, on July 18th and August 5th, and 27th and September 9th. Late blight also serious on unsprayed plants. The sprayed plots yielded 309 bu. per acre; the unsprayed 229, or 80 bushels per acre increase from spraying. Heath's Late Beauty variety was used in both cases. At Girard, the experiment was also performed in 1919, using the Petoskey variety. Late blight practically absent. Average yield of plots sprayed seven times, 123.3 bushels; of those receiving only insecticide, 100.5 bu. per acre. Low yields because of badly sprouted seed. The middle to late season sprayings were found to be better when late blight was absent than late season spraying only.

Five applications of 4-4-50 Bordeaux, using pressure of 200 pounds and 100 or 125 gallons per acre, using two or three nozzles per row, gives protection against late blight in Pennsylvania and remarkable increases in yield whether late blight is present or absent.

Delaware.—T. F. Manns reports late blight not often serious. In 1912, 1913, and 1914, not reported; 1915, 1 per cent in northern part; 1916, little damage; 1917, 2 per cent of late potatoes affected; 1918, ½ of 1 per cent; 1919, 2 to 5 per cent of late potatoes affected. In 1920, late blight very severe; average of 10 to 20 per cent rot. F. D. Chester reported (5th Ann. Rep., 1892) co-operative spraying. In one case, yield was 96 pounds per row where sprayed 4 times; 92 pounds where unsprayed. Some blight present. Another plot yielded 101 pounds per row where sprayed 4 times; 84 pounds where unsprayed. No other data available.

Maryland.—J. B. S. Norton reported in 1906 (Bull. 108) that 3 years' tests showed an average increase in yield of 52 per cent from spraying 3 or 4 times from June to September.

Virginia.—Director T. C. Johnson and L. B. Smith of the Truck Experiment Station report that late blight rarely does any damage in eastern Virginia; but early blight and tipburn are common. Late blight occasional in western Virginia. Results of work show that profit was obtained by using Bordeaux as a carrier for arsenicals. (Bulls. 14, 17, 28). Bulletin 29, and Potato Magazine, Aug. 1919, report results showing that nicotine sulphate, fish-oil soap, and water kill more aphids than Bordeaux, arsenate and nicotine; but the latter combination gave an average of more than 25 bu. per acre increase in yield over the former. Bordeaux and arsenate gave about the same yield as the nicotine and soap, although Bordeaux does not affect aphids particularly. L. B. Smith reports Bordeaux effective for early blight in 1920.

West Virginia.—N. J. Giddings has published (Ann. Rep., 1909–10 Bull. 165) results of spraying tests. The results of spraying on a commercial scale, in years when very little early or late blight appeared, are as follows:

TABLE 3.

Results of Spraying Potatoes in West Virginia

YEARS	LOCATION OF PLOTS	AV. YIELD, SPR. PLOTS	AV. YIELD, UNSPR. PLOTS	INC. FROM SPR. BU.	INC. FROM SPR. PER CENT
1909, '12, '13	Morgantown	87.2 bu.	70.5 bu.	16.7	23.7
1911, 1912	Moundsville	78.1 "	69.4 "	8.7	12.6
1910	Reedsville	82.3 "	59.1 "	23.2	39.3

Lime sulphur reduced yields. In 1919, Professor Giddings sprayed Carman No. 3 with 5-5-50 Bordeaux, at an altitude of over 3,000 feet, using one acre spray plots and

one-half acre check plots, and obtained a 50 per cent increase in yield. Favorable results from spraying were secured also in 1920.

North Carolina.—R. W. Leiby has tested poisoned Bordeaux and Bordeaux without poison, with hand-picking the beetles, and with no spraying whatever. (Ext. Circs. 48, 103; Bull. N. C. Dept. Agr. 254). For the late crop in western N. C., an average for 6 years gave an increase of 52 bu. per acre from poisoned Bordeaux over check without Bordeaux or poison. Four similar tests in eastern N. C. gave an increase of 26 bu. per acre. Five years' results gave an average increase of 16.6 bu. per acre from poisoned Bordeaux as contrasted with Bordeaux alone.

South Carolina.—Director H. W. Barre reports late blight quite prevalent in Charleston and Beaufort Counties in 1920. Some spraying tests, but no figures as to effect on yield. Late blight seldom occurs.

Georgia.—H. P. Stuckey and B. B. Higgins (Bull. 123) reported for 1915 an average yield of 66 bu. per acre where sprayed twice with 4-5-50 Bordeaux mixture, and an average of 49.5 bu. per acre without Bordeaux. Increase in yield also reported in 1916. Late blight absent; but early blight common on unsprayed plots. No other data at present from Georgia.

Florida.—C. D. Sherbakoff reports late blight in 1912, 1917, 1918, and 1919. In 1919, the blight caused a loss of 50 per cent in the Hastings district. Cooperative experiment in 1919 with grower, leaving 3 distributed strips unsprayed, each 4 rows wide and 200 feet long, in each of two test fields of 20 acres. Results as follows:

Field 1. 20 acres new ground, sprayed 5 times beginning when plants were 8–10 inches high. Field planted on January 25th and 26th, 1919.

Field 2. 20 acre tiled field, planted on Feb. 7th and 8th, 1919, sprayed 7 times begining when plants were 5–6 inches high. Average yields were as follows:

Sprayed	rows,	field 1,	160.3	lbs.	No. 1	potatoes;	total	225.7	lbs.
Unspr'd	"	" 1,	115.3	"	" 1	"	"	184.7	"
Sprayed	"	" 2,	258.3	"	" 1	"	"	327.7	"
Unspr'd	"	" 2,	170.3	"	" 1	"	"	243.3	"

The above figures are for 2 rows, and are the average of the 3 counts in each case. Average increase in yield where sprayed, 29 per cent, and 45 per cent increase in No. 1 potatoes. Average yield of field No. 1, 31 barrels per acre; field No. 2, 43 barrels per acre. Cost of spraying the 40 acres, about $286; increased yield worth $2,210. Further data in Florida Grower 20, No. 1, 1919. Probably would pay to spray each year in Florida; though results when late blight is absent not yet determined.

Ohio.—A. D. Selby reports potato spraying not commonly practised, because Ohio has late blight less than 40 per cent of the seasons. Spraying pays when late blight occurs. Value to growers of applying Bordeaux each year not definitely known.

Indiana.—H. S. Jackson reports late blight rare or absent; early blight not serious; tipburn serious. F. C. Gaylord wrote in 1918 that very few growers used Bordeaux; but those who did considered that it paid. No results of experimental tests available.

Illinois.—G. P. Clinton reported (Bull. 40, 1895) some increase from spraying potatoes with Bordeaux and poison. J. Pieper writes that farmers who have made comparisons feel that there is considerable advantage in the use of Bordeaux. No definite figures.

Michigan.—G. H. Coons writes that Michigan potato spraying must give protection against early blight, hopper burn and late blight. Of these early blight is probably least important, and hopper burn, because it is present nearly every year, is probably the greatest loss producer, Late blight so far as available records show has been

present in epidemic form in 1885, 1896, 1900, 1902, 1903, 1905, 1912, 1915, 1920. Since 1911, it can definitely be stated that hopper-burn has reduced the potato crop 25 per cent in the case of late potatoes and 50 per cent in the case of early potatoes, working along with drought to depress the average yield per acre for the state in some seasons as low as 60 bushels.

A questionnaire to leading potato dealers, county agents, and potato growers showed that potato spraying was not at all generally practiced, some of the counties growing large acreages of potatoes reporting that spraying for diseases was not practiced at all.

Evidence as to value of spraying is not available for any consecutive period. The college has carried on many demonstrations since 1890; but results of these are not available. C. A. McCue (Bull. 236) obtained in 1905, a year when late blight was a factor, increases of 28 to 40 bu. per acre from 4-4-40 Bordeaux applied 4 to 14 times, and an increase of 11.5 bu. per acre from lime alone applied 14 times. He also reported large increases in yield from certain farmers' trials.

In 1912, H. I. Eustace (Circ. 15) published the results of spraying tests made in several preceding seasons, reporting that spraying paid during the absence of blight. In 1911, an increase of 39 bu. per acre was obtained from 4 applications of Bordeaux.

For twenty years, Hon. Jason Woodman, a progressive farmer in southwestern Michigan, has sprayed potatoes as part of the farm practice. These tests with land well adapted to potatoes and heavily fertilized have given the best results yet obtained in influencing yields. Mr. Woodman reports an average gain of the sprayed over the check every year with one exception, and in this year, the spraying was done with commercial Bordeaux. The average gain from spraying for the period is put between 75 and 100 bu. per acre.

FIG. 1. A CONSPICUOUS EXAMPLE OF THE EFFECT OF BORDEAUX, CENTER TWO ROWS UNSPRAYED. Photographed in 1915 near Kalamazoo, Mich., by C. W. Ward. By courtesy of G. H. Coons.

In 1915, spraying tests by farmers near Kalamazoo, Michigan, gave increases in yield of 130 to 166 bu. per acre from 5 sprayings.

G. H. Coons (Spec. Bull. 85, 1918) advises spraying every year for those growing potatoes intensively, and everyone should spray, if July is cold and wet.

Wisconsin.—Spraying often necessary because of late blight. J. G. Milward and R. E. Vaughan report favorable results from spraying even in the absence of late blight. from increased foliage growth and protection against flea-beetle and leaf hopper damage. Potato spraying on increase among progressive growers, and better machines are being introduced. R. D. Rands (Wis. Res. Bull. 42, 1917) reported an average of slightly over 10 per cent increase in yield for early varieties, and from 10 to 43 per cent increase in yield for late varieties from the use of Bordeaux in the absence of late blight. Early blight was profitably controlled by spraying.

Minnesota.—Late blight not uncommon; early blight and tipburn (principally hopper burn) common. G. R. Bisby and A. G. Tolaas have summarized (Bull. 192) the results. The average increase for 14 years at St. Paul was over 31 bu. per acre for late varieties, and about 27 bu. per acre for early varieties. Experiments elsewhere in the state also demonstrate that the application of 5-5-50 Bordeaux pays even in the absence of late blight. Weaker Bordeaux found less valuable. Some indication of better yield succeeding year from tubers produced under sprayed vines.

Iowa.—Late blight not common. A. T. Erwin, bulletin 171, 1917, reported five years' result of spraying against tipburn and early blight. Marketable potatoes yield as follows, average 5 years: 3 applications 5-5-50 Bordeaux, 114.3 bu. per acre; 5 applications, 120.9 bu.; 7 applications, 121.5 bu.; check, 103.9 bu. Cost figured at $0.96 per application per acre. Five applications most profitable. The Departments of Entomology and Plant Pathology cooperated in 1920 in experiments with Bordeaux 4-4-50 plus black leaf 40, one pint per 100 gallons of mixture, and report fair control of tipburn. In one field, average 0.14 nymphs of leaf hopper per leaf where sprayed, and 0.50 where unsprayed. Many nymphs killed.

Missouri.—J. T. Rosa, Jr., reports that spraying has not been practiced by growers for the control of diseases. No data as to the effect on yield. Early blight not ordinarily serious, tipburn the main limiting factor in growing potatoes in this section during the summer season. Late blight practically absent.

Manitoba, Saskatchewan. Alberta.—Late blight absent because of dry atmosphere, early blight and tipburn uncommon. Experiments with Bordeaux not yet tried. In areas in Manitoba and Saskatchewan, and around Edmonton, Alberta, the Colorado beetle is rare or absent, so that even insect sprays are not applied. Flea beetle quite common, aphids often abundant late in the season, leaf hoppers not serious.

North Dakota.—No late blight. Early blight and tipburn not serious. H. O. Werner found (Bull. 129) increased yield to result from Bordeaux.

South Dakota.—Late blight rare, early blight and tipburn common. Manley Champlin reported Bordeaux mixture little used. Materials are difficult to obtain throughout the state. In 1918, tests at Brookings gave yield of 96.7 bu. per acre sprayed with Bordeaux, and 78.3 bu. per acre without Bordeaux for Early Ohios, and 67.5 and 84.2 bu. per acre respectively for "Bugless." Reasons for inconsistent yields uncertain. No other data available.

Nebraska.—G. L. Peltier reports no data as to the results of spraying. Early blight and tipburn present.

Kansas.—L. E. Melchers performed spraying experiments during 1918, 1919, and 1920. The results are important, for, in Kansas, late blight does not occur; but early blight, tipburn, and hot weather cut down the yield. Melchers' figures cannot be given in full here. In 1918, a half acre plot planted to northern grown seed was sprayed by H. H. Haymaker with 2-3-50, 3-4-50, and 4-5-50 Bordeaux plus lead arsenate, four or three applications. Average yields per row were as follows:

	2-3-50	3-4-50	4-5-50
Irish Cobbler	28.75 lbs.	31.42 lbs.	30.17 lbs.
Corresponding check	27.12 "	31.75 "	38.00 "
Early Ohio	31.42 "	35.42 "	39.25 "
Corresponding check	30.37 "	37.75 "	35.25 "

In 1919, a similar experiment was performed. The results from various strengths of Bordeaux and various schedules are as follows:

Variety	Treatment	Av. yield per row	Inc. in yield per row	
			lbs.	per cent.
Irish Cobbler	checks	85.00		
Irish Cobbler	sprayed	89.25	4.25	5.00
Early Ohio	checks	69.66		
Early Ohio	sprayed	72.50	2.84	4.00

The 4-5-50 Bordeaux gave the best results, the 3-4-50 next best, and the 2-3-50 the poorest results.

In 1920, the experiment was carried on in a ten acre field of the best known grower in the Kaw Valley. Early blight and tipburn almost absent, a rare condition in Kansas. The average yield of sprayed Early Ohios was 281.4 bu. per acre; unsprayed, 280.9; of Irish Cobbler: sprayed, 282.0; unsprayed, 303.0.

Under Kansas conditions, the three seasons' evidence indicates that Bordeaux mixture exerts little influence on the yield.

Kentucky.—W. D. Valleau reports tests at Lexington in 1920 with two sprayings in the spring, which resulted in about ⅓ increase in yield. Late blight rare; early blight slight; tipburn common.

Tennessee.—S. M. Bain published bulletins (Vol. **8**[1], Vol. **15**[2]) dealing with fungicides, but no data as to the effect of Bordeaux on potatoes.

Alabama.—G. L. Peltier reports that potato spraying experiments have not been performed. Early blight and tipburn often present.

Mississippi.—D. C. Neal reports that late blight has not been found. Early blight common and spraying would probably pay, but no data available.

Louisiana.—C. W. Edgerton reports that late blight has been found, but that conditions are not suitable for its general development. Early blight and tipburn not ordinarily serious. Value of Bordeaux unknown.

Texas.—J. J. Taubenhaus reports late blight absent; early blight and tipburn present. Tipburn worse on plants from potatoes injured by frost in transit to Texas. Potatoes grown as an early crop. No definite figures as to the effect of spraying.

Oklahoma.—No experimental data found as to the effect of spraying potatoes with Bordeaux mixture.

Arkansas.—J. A. Elliot reports late blight rare, early blight not very serious, tipburn rather serious. Bordeaux used in 1920, but no effect on yield. Different number of applications also gave little difference.

Montana.—Late blight absent; early blight and tip-burn not serious. D. B. Swingle reports no data as to the effect of Bordeaux on yield.

Wyoming.—A. F. Vass reports no publications on this subject.

Colorado.—H. G. MacMillan reports tipburn and early blight slight; late blight absent. No data as to the effect of Bordeaux.

New Mexico.—F. C. Werkinthin wrote in 1918 that late blight does not occur, and early blight is not common. L. H. Leonian wrote in 1920 that no data had yet been obtained as to the effect of using Bordeaux.

Arizona.—J. G. Brown reports early blight reduced yield 30 per cent in 1919, and 5 per cent in 1920, in northern Arizona. Bordeaux has been used successfully for early blight, but no figures available.

Utah.—B. L. Richards states that tipburn is serious. Early and late blight do not cause damage. Value of Bordeaux unknown.

Nevada.—C. W. Lantz reports Nevada not troubled with diseases which make spraying necessary. No data as to effect of Bordeaux.

Idaho.—C. W. Hungerford reports late blight absent; early blight and tipburn not serious. Growers do not use Bordeaux. No data as to its effect on yield.

British Columbia.—W. Newton reported (Agr. Gaz. Can., **2:** 334, 1915) increases in yield of from 5 to 58 bu. per acre from spraying 3 and 5 times with a 4-4-40 (4-4-50 U. S. gallon) Bordeaux. This was during an unusually dry season when late blight was not very prevalent. French (Brit. Col. Circ. 10) reports that late and early blights do little damage in dry portions of British Columbia. J. W. Eastham has other data, received too late to include here.

Washington.—F. D. Heald reports Bordeaux used to a limited extent in the Puget Sound region where late blight occasionally occurs. Foliage troubles of potato rare in the Yakima Valley. Tests there in 1918 as follows:

No spraying, average of two tests, 255.5 lbs.
3-3-50 Bordeaux once, average two tests, 189.0 lbs.
3-3-50 Bordeaux twice, average two tests, 238.0 lbs.

No value from spraying in this experiment, where leaf diseases were absent. No other data at present available.

Oregon.—M. B. McKay reports early blight and tipburn slight, late blight about once in ten years west of Cascade Mountains, quite serious in 1920. No data as to effect of Bordeaux in Oregon.

California.—Tests began with copper-lime sprays in 1886 (See Exp. Sta. Rec. **41:** 405, 1919). J. T. Barrett reports early blight sometimes rather destructive especially to the second crop; but no data as to the value of Bordeaux on potatoes in southern California.

U. S. Department of Agriculture.—Much early work was done in testing and introducing Bordeaux after its discovery in France (see Lodeman, E. G., The spraying of plants, New York, 1913, for a summary of this work). L. A. Hawkins published, in 1912, a bulletin on "Some factors influencing the efficiency of Bordeaux mixture." (Bur. Pl. Ind., Bull. 265.) F. C. Cook of the Insecticide and Fungicide Laboratory has been testing lime-water and barium-water sprays (U. S. Dept. Agr., Bull. 866) and found them effective on potatoes. He also reports tests (Jour. Agr. Res. **20:** 623–636, 1921) indicating that the percentages of solids and of nitrogen is higher in tubers from sprayed vines than in tubers from unsprayed vines; but found no indication that tubers from sprayed vines produced sprouts with a composition or rate of growth different from sprouts from tubers from unsprayed vines.

SUMMARY AND CONCLUSION

Bordeaux is necessary to control late blight in the Maritime Provinces, in Quebec, in northern New England, and in New York. Increased yields are general in the absence of late blight. Late blight, is less common in Ontario, Rhode Island, Connecticut, New Jersey, Delaware,

Pennsylvania, Ohio, Michigan, Wisconsin, Minnesota, and Florida. Careful spraying each year, nevertheless, pays in Pennsylvania, and evidently also in Ontario, Michigan, Wisconsin, and Minnesota. Spraying Cobblers in New Jersey has been found to pay; but main crop Giants may be reduced in yield from Bordeaux. In Rhode Island and Connecticut, the late crop is in general benefited from spraying. Late blight occasionally occurs in certain other eastern and central states, and Bordeaux appears valuable in Maryland, Virginia, West Virginia, North Carolina, Georgia and perhaps Kentucky, although further experiments are needed in certain of these states. Spraying is, of course, valuable in any region in years in which late blight is serious. Bordeaux has been found valuable in Iowa and under certain conditions in North Dakota and British Columbia. Bordeaux did not exert much influence in Kansas during 3 years nor in Arkansas in 1920. The value of Bordeaux is uncertain over most of the rest of North America.

Copper dust appears valuable, as indicated by the Canada and New York reports. Burgundy mixture was found scarcely equal to Bordeaux in Canada. Work on the resistance of potato varieties to late blight has been performed in Rhode Island, Canada, and elsewhere: see Wm. Stuart, Vermont Sta. bulletins 115, 1905; 122, 1906; and 179, 1914, and L. R. Jones, U. S. Dept. Agri., Bur. Pl. Ind. Bulletin 87, 1905, and Jones, Giddings and Lutman U. S. Dept. Agr., Bur. Pl. Ind., Bulletin 245, 1912. Data on the chemical, physical, and biological effects of Bordeaux have been published by workers in New Hampshire, Vermont, U. S. Dept. Agr., Canada; see also Martin, Jour. Agr. Res. **7**: 529–548, 1916, Duggar and Bonns, Ann. Mo. Bot. Gard. **5**: 153–176 and Ritzema Bos, abstract in Bot. Abs. **3**: 235, 1920. Data from Virginia, Iowa, Maine, Wisconsin, and Canada refer to the use of various compounds with Bordeaux to kill insects.

It is evident from this summary that our knowledge of the value of Bordeaux mixture on potatoes is still very incomplete. Tests of Bordeaux and other compounds are needed in many parts of North America in order to determine their value under various conditions. There is excellent opportunity for cooperative spraying work with entomologists. The best fungicide to apply, its effect on the potato plant, and the optimum schedule for spraying potatoes, need further study. Many workers will desire to compare spraying and dusting. Questions of scientific interest as well as practical importance await experimentation. The results obtained will naturally be published by the workers; but the writer will gladly act in any capacity he can in correlating or bringing together miscellaneous information relative to the use of Bordeaux mixture and other fungicides on potatoes.

REPORT OF THE TWELFTH ANNUAL MEETING OF THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

The twelfth annual meeting of the Society was held at the Reynolds Club Theater, University of Illinois, Chicago, Illinois, December 27–31, 1920, in conjunction with the American Association for the Advancement of Science, the Botanical Society of America, and other scientific societies. President W. A. Orton presided. The headquarters of the Society were at the Fort Dearborn Hotel.

About one hundred and ten members were present, the largest attendance recorded at any of the annual meetings. Seventeen new members were elected, making the total active membership of the Society five hundred and twelve on January 1, 1921.

There were eighty papers on the regular program, abstracts of which appeared in the January number of PHYTOPATHOLOGY. Copies of the abstracts were distributed to all members of the Society in advance of the annual meeting and the new plan of conducting the sessions adopted last year at St. Louis was followed. The papers were not formally read, but the entire time of the sessions was devoted to informal discussion, the basis of the discussion being the published abstracts. Portions of two sessions were devoted to consideration of the diseases of potatoes and of beans.

There were three joint sessions with other societies. On Wednesday afternoon, December 29, occurred the annual meeting of Section G of the American Association for the Advancement of Science. At this meeting Dr. L. H. Pammel gave an address as Vice President of Section G on Some Phases of Economic Botany, and papers were presented by Dr. C. R. Ball, Dr. H. C. Cowles and Dr. F. L. Stevens in a symposium on the Relation of Botany to Human Welfare. On Thursday afternoon, December 30, the American Phytopathological Society joined in an invitation program with the Botanical Society of America and the American Society of Economic Entomologists. Papers were presented by Prof. C. V. Piper on Plants and Plant Culture, by Dr. E. C. Stakman on Recent Investigations on the Black Stem Rust of Wheat and Other Cereals, and by Dr. H. S. Shantz on Natural Vegetation and Agriculture in Africa. On Friday morning, December 31, a joint session was held with the American Association of Economic Entomologists, which was devoted to a discussion of dusting as a means of controlling injurious insects and plant diseases. Insect control by dusting was discussed by Dr. P. J. Parrott, Dr. T. J. Headlee, and Dr. A. L. Quaintance. Plant disease control was discussed by Dr. N. J. Giddings and Dr. H. A. Edson. These five papers, with a full report of the discussion which followed their presentation, will appear in the April number of the Journal of Economic Entomology, where they will be accessible to pathologists interested in the subject of dusting.

The annual dinner of the Society was held Thursday evening, December 30, at the Stevens Restaurant, and was attended by one hundred and twenty-five pathologists and botanists. After the dinner the stern visages of the assembled pathologists relaxed in kindly and tolerant appreciation of several toasts, and the "phytopathological anthem" was rendered by a quintet previously unknown to fame.

The following officers were elected:

President, Dr. Donald Reddick, Cornell University, Ithaca, New York.

Vice-President, Dr. G. H. Coons, Michigan Agricultural College, East Lansing, Michigan.

Councilor for two years, Dr. N. J. Giddings, West Virginia University, Morgantown, West Virginia.

Councilors for one year: (chosen by the divisions of the Society) Dr. J. H. Faull, University of Toronto, Canada, representing the Canadian division; Dr. H. S. Reed, Citrus Experiment Station, Riverside, California, representing the Pacific Coast division; and Dr. H. R. Rosen, University of Arkansas, Fayetteville, Arkansas, representing the Southern division.

Representative on the Board of Control of Botanical Abstracts, Dr. L. R. Jones, University of Wisconsin, Madison, Wisconsin.

Members of the editorial board of Phytopathology (chosen by the Council of the Society): Editor in Chief, Dr. Perley Spaulding, United States Department of Agriculture, Washington, D. C., associate editors for three years, Prof. J. Franklin Collins, Brown University, Providence, Rhode Island; Dr. L. R. Hesler, University of Tennessee, Knoxville, Tennessee; Dr. A. G. Johnson, University of Wisconsin, Madison, Wisconsin; associate editor for two years to fill vacancy, Prof. J. A. Stevenson, United States Department of Agriculture, Washington, D. C.; business manager for one year, Dr. G. R. Lyman, United States Department of Agriculture, Washington, D. C.; advertising manager for one year, Prof. Roy G. Pierce, United States Department of Agriculture, Washington, D. C.

The Society voted to hold its next annual meeting at Toronto, Canada, December 26–31, 1921, in conjunction with the American Association for the Advancement of Science.

REPORT OF THE TREASURER, 1920

Receipts:		
Balance from 1919	$1,070.60	
Membership dues	2,546.70	
Excess dues	28.00	
Exchange	7.50	
Subscription for exch. with International Inst. Agr.	5.50	
Copying list of members for A. Thomas	5.00	
Interest	31.78	$3,695.08
Expenditures:		
Member subscriptions	1,244.00	
Excess dues returned	28.00	
Discount Canadian checks	1.33	
Checks returned by bank	4.00	
Annual appropriation to PHYTOPATHOLOGY	200.00	
Clerical assistance	71.08	
Postage	23.00	
Printing	86.00	
Supplies	3.60	
Secretary's expenses, 1919	17.20	
Stationery, including stamped envelopes	76.65	
Loans to PHYTOPATHOLOGY	575.00	
Sinking fund transferred to PHYTOPATHOLOGY	1,000.00	
Subscription for exch. with Int. Inst. Agr.	5.50	$3,335.36
Balance		359.72
Amount due Phytopathology account—		
Sinking fund	$165.58	
Member subscriptions	29.00	194.58
Actual balance		165.14

During 1920 the Society lost seventeen members through death, resignation, and nonpayment of dues. The seventeen new members just elected exactly making up this loss. There are now eighty-six life sustaining members, and four hundred and twenty-six regular members, a total of five hundred and twelve.

Financial Statement of the Business Manager of Phytopathology, 1920

Receipts:			
Balance from 1919		$ 552.12	
Subscriptions and sales		1,370.34	
Publishing in PHYTOPATHOLOGY		527.60	
Annual appropriation from Am. Phyto. Soc		200.00	
Advertising in 1919		221.45	
Member subscriptions		1,244.00	
Interest		60.50	
Loans		1,375.00	
Sinking fund		1,500.00	$7,051.01
Expenditures:			
Manufacture of journal:			
No. 9, Vol. IX	$1,017.10		
No. 10, Vol. IX	316.42		
No. 11, Vol. IX	281.35		
No. 12, Vol. IX	359.03		
Balance on No. 9, Vol. IX	35.20		
No. 1, Vol. X	595.16		
No. 2, Vol. X	366.56		
No. 3, Vol. X	431.36		
No. 4, Vol. X	518.36		
No. 5, Vol. X	265.73		
No. 6, Vol. X	231.24		
No. 7, Vol. X	220.40		
No. 8, Vol. X	189.47		
No. 9, Vol. X	239.84		
Balance on bills	28.82		
Alterations	16.98		
Alterations	4.48		
Alterations	3.68	$5,121.24	
Miscellaneous		195.94	
Insurance		12.35	
Mortgage, sinking fund ($1500)		$1,470.00	$6,799.53
Balance			$251.48

An auditing committee, consisting of E. L. Nixon, J. A. McClintock, and R. E. Vaughan, was appointed to examine the accounts of the treasurer and businesss manager. This committee reported the accounts correct and the reports were adopted.

PHYTOPATHOLOGY

At the close of the phytopathologists' dinner on Thursday evening the business manager reported on the future plans of PHYTOPATHOLOGY:

"In 1918 there was issued a volume of six hundred and twenty-seven pages, in 1919 five hundred and eighty-seven pages, and in 1920 five hundred and fifty-four pages. During these years printing costs have risen enormously, but the pressure of accumulated manuscript in the hands of the editor-in-chief has made it impossible to reduce the number of pages sufficiently to keep pace with rising costs. The financial statement above shows loans of $1,375 contracted to pay current bills. It is estimated that if all outstanding bills against PHYTOPATHOLOGY up to December 31, 1920, were received and paid, the accounts would show a deficit of $1,787.36.

"These financial problems have been receiving very careful consideration by the Council. The deficit shown above has been steadily increasing for the past four years and the time has come when changes and adjustments must be made which will bring expenditures below receipts and permit the gradual liquidation of present indebtedness. The following plan has been decided upon and the business manager requests the cooperation of all members of the Society in carrying it out:

"1. The cost of manufacturing PHYTOPATHOLOGY must be reduced. Inquiry has shown that printing service can be purchased of well-established firms, experienced in producing scientific journals, at rates materially less than those charged by Williams & Wilkins Company, of Baltimore, Maryland. Accordingly relations with Williams & Wilkins Company have been severed and arrangements completed with the Intelligencer Printing Company of Lancaster, Pennsylvania, to manufacture PHYTOPATHOLOGY during 1921. The Intelligencer Printing Company already issues several botanical and other scientific journals and their prices are materially below those of Williams & Wilkins Company.

"2. Other costs must be reduced. The Williams & Wilkins Company have been handling subscriptions, advertising, and the sale of back numbers on a percentage basis, and also performing various other publishing services, for all of which PHYTOPATHOLOGY has been charged. The business manager will now assume direct charge of all these matters, and the Council has authorized him to select two assistants for this work. Through the courtesy of President A. F. Woods, the back numbers of PHYTOPATHOLOGY will be stored free of charge at the University of Maryland, College Park, Maryland, and will be under the immediate supervision of Prof. C. E. Temple and Prof. R. A. Jehle.

"3. Our revenues must be increased. To this end the hearty cooperation of all members of the Society is earnestly requested in securing new members, new subscribers, and new advertisements.

"This plan places a greatly increased burden upon the business manager and his immediate helpers, but the hearty backing of the whole Society is counted on, and it is confidently expected that in this way it will be possible to pay all costs and also enable PHYTOPATHOLOGY to discharge its obligations to phytopathological science in a manner worthy of the Society."

The Society approved of the plans as stated, and immediately voted unanimously to pay off by voluntary subscriptions of the members the deficit under which PHYTOPATHOLOGY is struggling. A canvass was taken of the members present, which resulted in $576.50 in cash and pledges. Prof. H. H. Whetzel was requested to bring the facts to the attention of all members of the Society not present at the dinner in an endeavor to raise the entire amount of the deficit, and thus relieve the journal of all handicap in inaugurating the new plan of operation outlined above.

REPORT OF THE ADVISORY BOARD

The Advisory Board reported through its chairman, Dr. G. R. Lyman, on the work

of the year. The custom inaugurated in 1919 of holding a summer field meeting was successfully continued. The 1920 meeting was held August 3–6, beginning in the Shenandoah Valley at Staunton, Virginia, and extending northward through West Virginia and Maryland to Gettysburg, Pennsylvania, one day being spent in each of the four states. The meeting was devoted chiefly to apple and peach diseases. Local arrangements were in charge of the plant pathologists of the states visited, and many demonstrations and exhibits of fruit diseases were prepared, as well as special comparative spraying and dusting experiments on the control of various diseases. About seventy-five plant pathologists were in attendance, together with a number of horticulturists, entomologists, and other specialists, representing the United States Department of Agriculture and the experiment stations in the United States and Canada. In addition the federal government detailed soil specialists from the Geological Survey, the Bureau of Soils, and the Bureau of Chemistry to attend the conference and participate in the discussions and relations of soils to plant diseases. W. B. Brierly, Head of the Department of Mycology, Institute of Plant Pathology, Rothamstead Experiment Station, Harpenden, England; Etienne Foëx, Directeur de la Station de Pathologie vegetale, Paris, France; G. Rossati, Royal Agrarian Delegate to the Italian Chamber of Commerce, New York City, and K. Nakata, Professor of Plant Pathology, Agricultural Department, Kiushiu Imperial University, Fukuoka, Japan, were present as the official representatives of England, France, Italy and Japan, respectively. A report on this meeting was published in the November number of PHYTOPATHOLOGY, pages 496–498.

Plans for the 1921 field meeting are already well advanced. The 1921 meeting will be devoted to cereal diseases and will be held July 19–22 in the vicinity of St. Paul, Minnesota, and Fargo, North Dakota. The following committee on arrangements has been appointed: E. M. Freeman, chairman, and H. L. Bolley, H. B. Humphrey and L. E. Melchers. It is expected that a number of foreign cereal pathologists will be present.

The Advisory Board has continued its service as the Committee on Phytopathology of the Division of Biology and Agriculture of the National Research Council. The most important matter considered in this connection during the year was the organization of the Crop Protection Institute, concerning which the members of the Society have already been informed. The Crop Protection Institute is the outcome of the spontaneous desire on the part of plant pathologists, economic entomologists, and certain business men to secure united attack on certain common problems. While this type of organization is in many respects an experiment, the association of these groups holds large possibilities of important service to agricultural science. The Institute has been organized under the auspices of the Division of Biology and Agriculture of the National Research Council.

Data for the 1920 list of active phytopathological projects are now being collected and it is hoped the list may be issued soon. The preparation of the 1920 list has been delayed by slowness on the part of pathologists in supplying information. There must be a more hearty response in the future if the preparation of this list is to be continued as an annual affair.

Some progress has been made during the year on certain cooperative projects. Prof. G. R. Bisby will shortly publish in PHYTOPATHOLOGY a report of progress on the potato spraying project, of which he is the leader. Dr. I. E. Melhus reports definite progress on the potato seed treatment project. During 1920 a cooperative project on dusting as a means of controlling plant diseases of orchard crops was inaugurated under the leadership of Dr. N. J. Giddings. Much interest has been manifested in this project and experiments were carried out during 1920 in a number of states.

THE PHYTOPATHOLOGICAL INSTITUTE

Dr. E. M. Freeman reported as chairman of the committee on the Phytopathological Institute. While the Institute has not been secured and funds are not yet in sight, there is cause for encouragement. Definite progress has been made in developing the fundamental idea of the Institute and in impressing influential persons with the need for such an institution. There is every reason to believe that a phytopathological institute will be established before many years.

RESOLUTIONS

On motion a committee on resolutions, consisting of E. A. Bessey, F. D. Kern, and J. H. Faull, was appointed by the president. This committee reported the following resolutions, all of which were unanimously adopted:

1. On the death of F. Kölpin Ravn.

The science of botany in general and of phytopathology in particular has suffered an almost irreparable loss in the sudden death of Denmark's great phytopathologist, Dr. F. Kölpin Ravn. His fame and usefulness far transcended the political boundaries of his native land. His several visits to America have always been a source of great inspiration and help to American investigators, with whom, on his part, he felt the greatest friendship. Dying suddenly in the course of a visit to this country, it is particularly fitting that the American phytopathologists express their sympathy and regret.

Therefore, Be It Resolved, That the American Phytopathological Society express by a rising vote our sense of the great loss suffered by science in the death of Dr. F. Kölpin Ravn, and furthermore the great personal loss felt by those who had learned to known and love his kindly helpful nature, and further:

Be It Resolved, That the secretary of this Society be instructed to transmit our expression of sympathy to the family of Dr. Ravn, to his colleagues at the Landbohojskölen, and to the Danish Government, and to spread these resolutions upon the minutes of the Society.

2. On the death of S. M. McMurran.

Whereas; The death of Mr. S. M. McMurran, pathologist in the Office of Fruit Disease Investigations of the Bureau of Plant Industry, United States Department of Agriculture, has robbed this country of an investigator of great ability and promise and a man of great personal worth;

Therefore, Be It Resolved, That this Society express by a rising vote its regret at Mr. McMurran's untimely death, and direct the secretary to transmit to his family the expression of our sympathy and to spread these resolutions upon the minutes of the Society.

3. On the publication of Farlow's Bibliographical Index.

Whereas; The development and progress of all studies on the various organisms which cause plant diseases are dependent upon an intimate knowledge of mycological literature; and,

Whereas; Farlow's Bibliographical Index of North American Fungi is an exhaustive compilation of mycological literature with valuable notes by Dr. Farlow; and,

Whereas; The first volume of the Index, which was published in 1905 by the Carnegie Institution of Washington, has proved to be invaluable to workers in the fields of plane pathology and mycology, both as a time saver, and as a guide to many workers; and,

Whereas; Dr. Farlow's death has brought his work upon the Index to a close;

Therefore, Be It Resolved, That the Carnegie Institution of Washington be respect-

fully urged to givr earnest consideration to the question of resuming publication of the Index in the near future.

4. On the work of Dr. Arthur.

Whereas; During his long and active life Doctor J. C. Arthur has accumulated a wealth of material upon the subject of rusts which is of immense value to science, and whereas it is highly desirable that following the completion of the treatise on rusts in the North American Flora Doctor Arthur should continue his writing and that all needed facilities and assistance should be furnished him.

Therefore, Be It Resolved, That the American Phytopathological Society approve the movement now under way to secure such facilities and request the Advisory Board to bring this subject to the attention of the National Research Council.

5. Of appreciation for courtesies shown.

Whereas; The University of Chicago has received the visiting scientists with a most cordial hospitality, and

Whereas; The local committee on arrangements has most successfully provided not only for the proper conduct of the meetings, but also for the comfort and entertainment of the visitors,

Therefore, Be It Resolved, That the American Phytopathological Society direct its secretary to express to President Judson its appreciation of the hospitality shown by the University, and to the chairmen of the local committees on arrangements its gratitude for, and recognition of the courtesies shown; and, further, to spread this resolution upon the minutes of the Society.

CROP PROTECTION INSTITUTE

The Council considered the organization and objects of the Crop Protection Institute and the responsibilities the Society was asked to assume in relation to it, and after discussion requested the Advisory Board to formulate a plan under which the American Phytopathological Society will be willing to participate in the work of the Institute. The following resolution was formulated by the Advisory Board and was recommended to the Society for adoption:

Resolved, That the American Phytopathological Society participate in the work of the Crop Protection Institute, with the stipulation that the connection of the scientific organizations with the Crop Protection Institute shall not be used for advertising purposes by the participating commercial concerns.

The Society voted to adopt the resolution and asked the Advisory Board to select three trustees to represent the Society on the Board of Control of the Institute. The Advisory Board selected F. D. Fromme, of Virginia Polytechnic Institute, for a term of three years; C. R. Orton, of the Pennsylvania State College, for two years; and G. H. Coons, of Michigan Agricultural College, for one year.

MISCELLANEOUS BUSINESS

The secretary's report of the eleventh annual meeting, held at St. Louis, as published in No. 4, Volume X of PHYTOPATHOLOGY, was adopted without correction.

On recommendation of the Council, the Society voted to appropriate from its available funds the sum of five hundred and seventy-five dollars for the use of Phytopathology during 1921; also that beginning with 1921 the treasurer be authorized to transfer three dollars of the annual membership dues, instead of two dollars as in the past, to the use of PHYTOPATHOLOGY. The Society also requested the Council to consider the desirability and feasibility of increasing the subscription price of PHYTOPATHOLOGY.

It was voted unanimously that a committee be appointed by the president of the Society to take the necessary steps to secure the establishment of an F. Kölpin Ravn fellowship in Phytopathology for the use of Scandinavian students. President Orton appointed L. R. Jones, Donald Reddick and A. G. Johnson. This committee was authorized to enlarge its numbers as might be found expedient.

ACTION OF THE COUNCIL

The Council reported the following action for the information of members of the Society:

The Divisions of the American Phytopathological Society. It was noted that the term of service of the three members of the Council chosen annually by the three Divisions shall begin at the close of the annual meeting of the Society next following their election by the Divisions and shall terminate with the close of the annual meeting one year later.

The Council voted that in the future, proceedings of the Division meetings, abstracts of papers presented, etc., shall be printed in PHYTOPATHOLOGY under the same rules which govern publication of similar matters relating to the general Society.

Phytopathology. It was voted to discontinue the publication in PHYTOPATHOLOGY of the lists of literature on plant diseases. This action was taken in accordance with the decision reached two years ago that the literature list would be discontinued as soon as Botanical Abstracts was in a position to list all literature. The omission of the list will permit the publication of seventy-five or more additional pages of regular text during the year.

The Council discussed the advisability of issuing an index to the first ten volumes of PHYTOPATHOLOGY. The secretary was asked to estimate the cost of such an Index and its probable sale before taking further steps.

Advisory Board. The Council selected G. H. Coons of Michigan Agricultural College to succeed H. S. Jackson as commissioner for the Middle West, and C. R. Orton to succeed himself as commissioner for the Northeast. The Council accepted with regret the resignation of H. W. Barre as commissioner for the South, and J. A. Elliott of the University of Arkansas was chosen to succeed him.

G. R. LYMAN
Secretary

ABSTRACTS OF PAPERS PRESENTED AT THE SECOND ANNUAL MEETING OF THE CANADIAN DIVISION, AMERICAN PHYTOPATHOLOGICAL SOCIETY, GUELPH, ONTARIO, DECEMBER 9 TO 10, 1920.

Studies on mosaic. B. T. DICKSON.

Mosaic is now known in thirty genera of ten families and mosaic-like diseases in eight genera of five families. True mosaic histological symptoms are hyperplasia of palisade parenchyma in light areas, reduction of chlorophyll content in those areas and generally, increase in trichomes and glandular hairs. On the other hand, there is frequently a hypertrophy of palisade tissue in dark areas due to hyperplasia. There is definitely less carbohydrate in the light parts. Mosaic of *Vicia faba* was described. Raspberry mosaic is differentiated from "yellows." No mosaic of the Cucurbitaceae has been found in Quebec by the writer.

Biologic forms of wheat stem rust in western Canada. MARGARET NEWTON.

At least five biologic forms of wheat stem rust have been shown to be present in western Canada. These forms were identical with five of the strains of rust previously isolated in the United States by Stakman. A rather virulent strain was found to be quite widely distributed. It was found in eight different localities of central Saskatchewan and eastern Alberta.

Biologic forms of wheat stem rust in western Canada. W. P. FRASER and D. L. BAILEY.

By greenhouse experiments in 1919 four distinct forms of stem rust were found to occur in wheat in western Canada. One of these was more common and widely distributed than the others. There were indications of several other biologic forms on wheat in the same region. All of the forms separated were identical with biologic forms which were found by Dr. Stakman and his co-workers to occur in the United States.

Leaf scorch or mollisiose of the strawberry. R. E. STONE.

This is a recently recognized disease of strawberries in Ontario. The disease is widely distributed extending from Sarnia in the western part of southern Ontario to Ottawa in the eastern part. The leaves present a scorched or blotched appearance and all the leaves on the plant may be killed, the latter taking on a dried, burned appearance. Entire strawberry patches may look as though burned over. In the summer the blotches bear a fungus known as *Marssonia potentillae* (Desm.) Fischer. This conidial stage may persist over winter on green leaves and to a certain extent on the dead leaves. On the dead over-wintered leaves an ascigerous stage develops. This stage has been identified as *Mollisia earliana* (E. & E.) Sacc. Ascospores from this fungus infect the leaves of strawberry plants and produce typical leaf scorch. Ascospores planted in nutrient agar-agar develop Marssonia which produced the typical disease when sprayed on strawberry plants. The conclusion was reached that *Mollisia earliana* (E. & E.) Sacc. is the perfect stage of *Marssonia potentillae* (Desm.) Fischer and the disease produced has been named according to the method of Stevens. Different varieties of strawberries are not equally susceptible to the disease. The order among those observed

seems to be; Clyde, Glen Mary, Senator Dunlop, Haverland, New Williams. Suggestions for control are; clean cultivation, destruction of old foliage and early spraying with Bordeaux mixture.

Experiments with Haskell's method or the so-called dry formaldehyde treatment for the prevention of oat smut. J. E. HOWITT.

This method has been tested for three successive years by the Department of Botany at the Ontario Agricultural College. In all, twenty-eight field trials under ordinary farm conditions have been made and 1677 bushels of oats treated by this method. The results have been uniformly satisfactory. No injury to the grain has resulted and the control of the smut has been almost perfect. In no case has there been more than a trace of smut in any field sown with treated seed, while the amount of smut in the field sown with untreated seed for check, averaged 5.8 per cent. The advantages of this method over those which have been practiced here are simplicity, rapidity and ease of application. In our experiments it was found that one hundred bushels of oats could be treated in fifty minutes by this method; that there was no waiting for the seed to dry after treatment; no danger of it sprouting or moulding or of the grain being swollen so that it would not run freely through the seed drill.

Upon the chemotactic attraction of fungi for slugs. A. H. R. BULLER

Published elsewhere.

The sound made by fungus guns and a simple method for rendering audible the puffing of Discomycetes. A. H. R. BULLLER.

Published elsewhere.

Development of the Geoglossaceae. G. H. DUFF.

Published elsewhere.

Studies in Fomes fomentarius. J. F. FAULL.

Published elsewhere.

Practical hints for the young plant pathologist. L. CAESAR.

The hints in this paper are intended almost exclusively for young pathologists who are working on diseases of orchard trees, bush fruits and vegetables and who are thrown largely upon their own resources.

A good academic training is essential as a foundation but such a training will not in itself make a man a successful pathologist. The following are just as important factors in success:

1. To have the right view point or ideal in one's work; namely, to help the growers by lessening the losses caused by plant diseases.

2. To secure as early as possible from actual experience a good working knowledge of the best methods of control known today for all the more important diseases in one's particular field of work, so that the pathologist may be a valuable advisor and guide to the grower as soon as possible.

3. To select for investigation, for several years at least, only such problems as are pressing and whose solution will be of much value to those for whom he is working. All side issues should be avoided and also, for the present, all problems that have baffled the most expert pathologists of the past.

4. To study diseases as far as possible in the field or orchard under their natural conditions or surroundings, laboratory study being supplementary or subsidiary to field study. Field study has not, as a rule, received its proper share of attention in the past.

5. To make very careful and accurate notes on everything that has even the least bearing upon the problem in hand.

6. To work in cooperation with the Entomologist or otherwise to secure a working knowledge of insects and insect control; because the application of insecticides and fungicides must often be combined.

7. To be tactful and honest, avoiding bluff as a most dangerous thing.

8. To be sure of one's facts, avoiding hasty conclusions.

9. To be an enthusiast and to persevere in face of difficulties.

Upon the ocellus function of the subsporangial swelling of Pilobolus. A. H. R. BULLER. Published elsewhere.